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EDITORIAL.

THE College Journal has of late years so considerably increased in size that it has been thought desirable in future to somewhat curtail its scope, and to relegate to the Annual Report of the College, which is issued in October, the matters of purely internal and annual interest, retaining for the Journal the record of research work and of any trials and demonstrations which are of general interest. Owing to the extension and organisation of the Research departments, it is probable that the record of investigation work will be considerably larger in future years, and the results of some of the original work will be published in other scientific journals, an abstract of which will appear in the College Journal, so that the Journal will each year contain a complete account of all the investigations carried on. The Research Staff is now formed into a Committee for the purpose of co-ordinating the work, and this committee acts in conjunction with an advisory research committee, containing representatives of the College Governors with the University representatives, together with the following gentlemen: Prof. H. E. Armstrong, Prof. R. H. Biffen, Prof. V. H. Blackman, Dr. E. J. Russell and Mr. J. C. F. Fryer.

The chief event of the year has been the establishment of the Research Fruit Plantation at East Malling, which should prove an invaluable adjunct to the College Horticultural Department, and, in time, of great practical service to the Fruit Growing Industry. The plan of work was laid down in conjunction with that carried on at the Long Ashton station, which is in connection with Bristol University, and was also discussed and endorsed by a representative meeting of Kent and Surrey fruit growers. A record of the station and of the scheme of investigation will be found at page 175 of the Journal.

Another event of interest has been the commencement and at the time of writing, the practical completion, of the new quadrangle, which will very considerably extend the accommodation for the administrative, teaching and research work of the College.

The cost of erection of this addition has been defrayed by a grant and loan from the Development Commissioners, on the recommendation of the Board of Agriculture, and by two donations, each of £500, from a generous donor who wishes to remain anonymous. It may be mentioned that during the last twelve years, a sum of £24,000 has been expended by the Governors on the College buildings, without any recourse to County rates, and the Counties have had full advantage of the extension and development of the College work consequent on these additions, without any extra expenditure on their part.

The appointment of Agricultural Organisers for the counties of the South-Eastern District will be the means of bringing local problems into closer touch with the College workers, and the organisers, who are on the honorary staff of the College will have an intimate knowledge of the investigation work, and so be in a position to disseminate among the practical men, the results of utility arrived at in the College laboratories and trial grounds.

The Continental war which is now raging, has taken away a very large number of College students, and some thirteen members of the teaching and research staff, and also the Clerk to the Governors, so that it is probable that there will be considerable interference with the development of the College during the next twelve months. The record of the College is, however, a fine one, as out of 160 students, 114 are serving their country in some capacity, and a very large number of old students are also enrolled, as well as clerks, College servants, farm and garden workers and other employés. A special contingent—the Wye College contingent—numbering seventy-four—was attached to the 5th Battalion the Buffs.

The outbreak of war with Germany has brought into greater prominence the extent to which we are dependent on that country for certain important manufactures. Amongst those are dried vegetables, which are almost a necessity for troops at the front or in camps, where transport is of importance, and for ships of war and the passenger and merchant services. The College was asked by the Development Commissioners to investigate certain methods of preserving both fruit and vegetables with the object, first of conserving the glut of these products which so often occurs and secondly, of securing supplies for such services as are given above. It was found on enquiry that most of the dried vegetable supplies came from Germany, and the plant for the manufacture was also of German make. The Government Departments have therefore made grants to the College to enable them to investigate the different systems of drying and experiments are now being instituted on the methods of drying: (1) by hot air and natural draught; (2) by hot air and forced draught; (3) in vacuo; and it will then be seen whether it is worth the while of manufacturers to instal plants for the production of these commodities and to establish the industry in this country.

Another matter which is being investigated by the College research workers is the cause of, and practicable remedies for, nettle-head in hops, which is generally attributed to eel-worm attack. During the past two seasons there has been in certain districts a considerable increase of this trouble, and in the College garden much damage has been occasioned. Progress of such an investigation must necessarily be slow, but it is hoped to issue a report shortly with some preliminary observations on the disease.

The Kent Commercial Fruit Show, which was held for the third time, was exceedingly well attended at Maidstone. A comparative statement of the figures of the three shows demonstrates the great increase, both in the number of the exhibits and the attendance of those interested, which has

taken place. The show was officially visited by the Netherlands Horticultural Association, which translated into Dutch and issued widely in Holland and Belgium the pamphlet published by the College on Fruit Packing in Boxes.

The Board of Agriculture—to which the College is much indebted for help in many directions—made a grant towards the cost of erection of the Research Greenhouses which have been built on the College grounds and which will give much needed facilities for the investigation of plant pathological questions, and also for the work which is being done on flax breeding. An Insectary is also being erected which will form a welcome addition to the Entomological Department.

REPORTS

FROM THE

AGRICULTURAL DEPARTMENT.

RESULTS OF FARM EXPERIMENTS IN 1913.

By C. HUTCHINSON, B.Sc.

GRAIN YIELDS ON TRIAL PLOTS, 1913.

BARLEY.—New seed of each variety.

SEEDING.—3 bushels per acre.

The plots were on Field 7, across the plots in the Green Fodder Rotation of the previous year.

Variety.	Yield per acre—56 lbs. per bushel.								
	Head.			Tail.		Total.			
	qrs.	bus.	lbs.	bus.	lbs.	qrs.	bus.	lbs.	
Burton Malting	4	3	32	3	49	4	7	25	Barley of good quality.
Plumage (Beavan's Selected)	4	7	13	4	16	5	3	29	Straw long and grain of moderate quality.
Archer (Beavan's Selected)	5	0	24	5	1	5	5	25	Fair quality grain.
Plumage-Archer Hybrid (Beavan's)	6	4	8	4	42	7	0	50	This plot looked well throughout the whole season.
Maltster	5	0	5	3	28	5	3	33	Sample similar to Brewer's Favourite.
Invincible	5	2	31	5	5	5	7	36	The straw lodged before the grain filled and a moderate barley resulted.
Chevalier (Hallett's)	5	2	15	3	34	5	5	49	Lodging was very marked in this plot, and a poor quality of grain resulted.
Golden Grain	5	2	31	5	14	5	7	45	Barley bold, but a poor colour.
New Binder	4	6	8	2	43	5	0	51	Both produced a good class malting barley.
Brewer's Favourite	4	5	0	3	0	5	0	0	

OATS.—New seed of each variety.

SEEDING.—4 bushels per acre.

Variety.	Yield per Acre. 42 lbs. per bushel.	qrs.	bus.	lbs.	
Abundance	Head	5	4	24	The seed of this variety germinated irregularly and a moderate plot was the result throughout the season.
	Tail		1	3	
	Total	5	5	27	
Record	Head	6	4	19	Germination—Good but slow. Straw of medium length. Grain of good quality.
	Tail		1	20	
	Total	6	5	39	
Triumph	Head	10	2	18	Germination good. Straw long and ears heavy. Grain, good quality. For yield of straw and grain this variety is very promising.
	Tail		1	13	
	Total	10	3	31	
Yielder	Head	8	3	18	Germination rapid and good. Straw, short and stout. Grain, good quality, bushel weight, 43 lbs.
	Tail			34	
	Total	8	4	10	
Leader	Head	9	3	26	Germination, fairly good. Straw, long. Grain, not well filled, bushel weight, 39 lbs.
	Tail		1	31	
	Total	9	5	15	
Banner	Head	10	2	13	Germination, poor; the plant thickened out well. Straw and grain, fair quality.
	Tail		1	35	
	Total	10	4	6	
Besseler's Prolific	Head	8	0	14	Germination, good. Straw, plentiful and strong. Grain, fair quality.
	Tail		1	17	
	Total	8	1	31	

Plots were on Field 8—a thin calcareous soil. Each plot was about ½ acre in extent and extended from the Cold Harbour Road to Field F, and across the rectangular strips of the previous year's cropping.

WHEAT.—

SEEDING.—$2\frac{3}{4}$ bushels per acre.

Plots were on Field 3.

Variety.	Seed.	Yield per acre.	Miller's Valuation of Grain per quarter of 504 lbs.
Burgoyne's Fife	Once grown	34 bushels	36/-
Garton's Victor	Once grown	51 ,,	33/-
Wilhelmina	New seed	$58\frac{1}{2}$,,	32/6
Champion	,,	$50\frac{1}{2}$,,	32/-
Blue Cone	Once grown	24 ,,	31/-

The Blue Cone was harvested later than the other varieties, and the loss of grain on the acre plot due to the ravages of birds was so considerable after other corn was gathered, that the figure given cannot be taken as representing the yielding capability of this variety.

RESULT OF MANURIAL EXPERIMENTS ON POTATOES, 1913.

VARIETY.—Eclipse, an early potato.

MANURING.—20 Tons Dung per acre over the whole field.

Artificial Manures.	Yield per acre.	tons.	cwts.	qrs.
Plot I.—				
3 cwts. Superphosphate per acre	Ware	7	6	3
$1\frac{1}{2}$,, Sulphate of Potash per acre	Seed	1	10	1
$1\frac{1}{2}$,, Sulphate of Ammonia per acre	Chats		12	1
(Sown after mixing.)				
	Total	9	9	1
Plot II.—				
3 cwts. Superphosphate per acre	Ware	6	11	1
$1\frac{1}{2}$,, Sulphate of Potash per acre	Seed	1	9	2
$1\frac{1}{2}$,, Nitrolim per acre	Chats		8	0
(Sown separately at time of planting.)				
	Total	8	8	3

		Yield per acre.		
Plot III.—		tons	cwts.	qrs.
3 cwts. Superphosphate per acre	Ware	7	3	1
1½ ,, Sulphate of Potash per acre	Seed	1	6	0
3 ,, Nitrolim per acre	Chats		7	2
(Sown separately at time of planting.)				
	Total	8	16	3

Plot IV.—				
3 cwts. Superphosphate per acre	Ware	5	12	0
1½ ,, Sulphate of Potash per acre	Seed	1	3	0
1½ ,, Nitrolim per acre	Chats		5	3
(Sown after being mixed for 24 hours.)				
	Total	7	0	3

VARIETY.—Dalhousie, a maincrop potato.

MANURING.—14 tons Dung per acre over the field.
Artificial Manures per acre
sown in drills.

Plot I.—				
3 cwts. Superphosphate	Ware	11	4	0
1¼ ,, Sulphate of Potash	Seed		15	0
1¼ ,, Sulphate of Ammonia	Chats		14	0
(Mixed before distribution.)				
	Total	12	13	0

Plot II.—				
3 cwts. Superphosphate	Ware	10	6	0
1¼ ,, Sulphate of Potash	Seed		17	0
1¼ ,, Nitrolim	Chats		18	0
(Distributed separately.)				
	Total	12	1	0

Plot III.—				
3 cwts. Superphosphate	Ware	10	9	0
1¼ ,, Sulphate of Potash	Seed	1	7	0
2½ ,, Nitrolim	Chats		17	0
(Distributed separately.)				
	Total	12	13	0

Plot IV.—

		Yield per acre.		
		tons.	cwts.	qrs
3 cwts. Superphosphate	Ware	9	18	0
1¼ ,, Sulphate of Potash	Seed	1	6	0
1¼ ,, Nitrolim	Chats		13	0
(Distributed 24 hours after mixing.)				
	Total	11	17	0

MANURING OF MANGELS.

RESULTS OF TOP DRESSING, 1913.

Plots.—¼ acre.

Variety.—" Yellow Globe."

General Manuring.—

14 tons Dung in winter.

3 cwts. Superphosphate
1 cwt. Muriate of Potash
1 cwt. Sulphate of Ammonia
} At time of sowing, April 23rd.

1 cwt. Nitrate of Soda, May 24th.

	Yield per acre.		
	tons	cwts.	qrs.
Plot I.— No further dressing	27	6	3
Plot II.— Nitrate of Lime— 1 cwt. per acre on June 7th, 1 cwt. per acre on July 10th	32	14	3
Plot III.— Nitrate of Ammonia— 1 cwt. per acre, June 7th, 1 cwt. per acre, July 10th	35	15	2
Plot IV.— Nitrate of Soda— 1 cwt. per acre, June 7th, 1 cwt. per acre, July 10th	32	17	0

RESULTS OF SPRAYING TRIALS 1913 ON FIELD C.

Plots :—½ acre to 1 acre. Variety of Potato :—Cora—Scotch Seed.

SPRAY USED.	DATES OF SPRAYING.	YIELD PER ACRE. W=Ware. S=Seed. C=Chats. T=Total.	T.	C.	Q.	APPEARANCE OF HAULM.
PLOT I. BORDEAUX MIXTURE 14 lbs. Copper Sulphate 9 lbs. Lime 100 gallons Water 120 gallons per acre at each spraying	July 9th July 25th August 13th	W. S. C.	10 1 1	12 2 11	0 2 0	A healthy growth of haulm, disease appeared slightly September, third week.
		T.	13	5	2	
PLOT II. HERROD'S DRY SPRAY 28 lbs. per acre at each spraying	July 9th July 25th August 13th	W. S. C.	10 1 1	2 13 0	0 0 0	The haulm from the middle of August was a less intense green than Plot I., the disease appeared slightly earlier than on Plot I., and made more rapid headway.
		T.	12	15	0	
PLOT III. HERROD'S DRY SPRAY 28 lbs. per acre at each spraying	July 9th July 25th	W. S. C.	10 1 	4 6 18	0 0 0	Not distinguishable from Plot II.
		T.	12	8	0	
PLOT IV. "STRAWSONITE DRY SPRAY" 28 lbs. per acre at each spraying	July 9th July 25th August 13th	W. S. C.	10 1 	12 5 17	0 0 0	Ditto.
		T.	12	14	0	
PLOT V. No Spray		W. S. C.	9 1 	12 10 17	0 0 2	Disease in the haulm was apparent early in September, but a sound crop of tubers was raised in mid October.
		T.	11	19	2	

PLOT VI. BORDEAUX MIXTURE (v. Plot I.)	July 9th	W. S. C. T.	9 1 12	15 13 15 3	0 2 0 2	Disease only slightly less than on Plot V.
PLOT VII. BORDEAUX MIXTURE (v. Plot I.)	July 25th	W. S. C. T.	9 2 12	12 6 19 18	2 2 1 1	Disease less apparent than on Plot VI., but more marked than on Plot VIII.
PLOT VIII. BORDEAUX MIXTURE (v. Plot I.)	July 9th July 25th	W S. C. T.	10 1 13	10 16 19 5	0 0 1 1	Intermediate between Plots VII. and I.
PLOT IX. BURGUNDY MIXTURE 14 lbs. Copper Sulphate $17\frac{1}{2}$ lbs. Washing Soda 100 gallons Water 120 galls. per acre at each spraying	July 9th July 25th	W. S. C. T.	10 1 12	7 2 12 1	0 0 3 3	Haulm less vigorous than on Plot VIII. shortly after the first spraying, and the difference became more marked later. The plot at the time of raising closely resembled Plot VI.
PLOT X. IRISH BORDEAUX MIXTURE 20 lbs. Copper Sulphate 15 lbs. Lime 100 gallons Water 120 galls. per acre at each spraying	July 9th July 25th	W. S. C. T.	11 12	5 19 13 17	0 2 0 2	More vigorous growth of haulm than on any other plot, and the disease made slower progress after its presence was apparent.

MANURING OF MEADOW LAND on Cook's Field.

Plots 2, 3, 4 and 5, received equal weights of Nitrogen and Phosphate.

The weights of hay given are 15 per cent. less than the weight of hay as carted.

4A. Sulphate of Ammonia, 136 lbs. Superphosphate, 308 lbs. per acre. Hay, 1 ton 15 cwts.	1. 15 tons Dung per acre. Hay, 2 tons ½ cwt.
5A. Nitrolim, 140 lbs. Superphosphate, 308 lbs. per acre. Hay, 1 ton 3¼ cwts.	2. Fish Guano, 3 cwts. Superphosphate, 152 lbs. per acre. Hay, 1 ton 12 cwts.
6A. No Manure. Hay, 19 cwts.	3. Bone and Meat Meal, 3 cwts. Sulphate of Ammonia, 30 lbs. per acre. Hay, 1 ton 9 cwts.
1A. 15 tons of Dung per acre. Hay, 1 ton 16 cwts.	4. Sulphate of Ammonia, 136 lbs. Superphosphate, 308 lbs. per acre. Hay, 1 ton 10 cwts.
2A. Fish Guano, 3 cwt. Superphosphate, 152 lbs. per acre. Hay, 1 ton 1 cwt.	5. Nitrolim, 140 lbs. Superphosphate, 308 lbs. per acre. Hay, 1 ton 3 cwts.
3A. Bone and Meat Meal, 3 cwts. Sulphate of Ammonia, 30 lbs. per acre. Hay, 1 ton 2 cwts.	6. No Manure. Hay, 1 ton 2 cwts.

Experiment in Top Dressing of Meadows.

HAY YIELDS IN 1912 and 1913.

	1912 (½ cwt. per acre)	1913 (1 cwt. per acre)
Nitrate of Lime ..	31 cwts.	38 cwts.
Nitrate of Ammonia ..	—	39¾ cwts.
No Manure ..	20¼ cwts.	30¼ cwts.

SECOND REPORT OF THE COST OF FOOD, IN THE PRODUCTION OF MILK.

INTRODUCTION.

Two years ago the College published a report dealing with the cost of food in the production of milk in the counties of Kent and Surrey, and based on information collected from over sixty farms.*

The results obtained were of great interest and value to dairy farmers in the above and other counties, and led to greater attention being given to the quantity and cost of the rations actually used. At the same time the opinion was expressed by several practical farmers who were consulted on the subject, that more accurate results would be obtained if periodical visits were paid during the winter months to a smaller number of farms, so that allowance could be made for whatever variation might take place in the amount of the ration, in the price of the concentrated foods used, and in the number of newly-calved cows or heifers in the herd.

In deciding on the method to be followed in the continuation of the work, this criticism was kept in mind, also the necessity for assisting farmers to keep systematic milk records of the cows in their herds, and finally the following scheme was prepared and submitted to a number of dairy farmers.

OBJECTS OF THE INVESTIGATION :—

1.—To obtain further information as to the cost of food in the production of milk, and to correct or verify the conclusions drawn from the previous investigation.

2.—To obtain particulars as to the quantity and quality of the milk produced at the morning and evening milkings.

3.—To encourage farmers in the keeping of records of the quantity and quality of the milk produced, and of the food consumed by their cows.

* First Report on the Cost of Food in the Production of Milk in the Counties of Kent and Surrey, by J. Mackintosh.

Method of the Investigation :—

It is proposed that a representative of the College (a Milk Recorder) should visit each farm at intervals of a month. The farmer is asked to supply the Recorder with particulars as to the feeding of the cows, while the Recorder will weigh and take samples from the milk of each cow in the herd, evening and morning, also samples of the mixed milk and despatch these to the College to be tested.

Details of the co-operation of Farmer and College may be summarised as follows :—

By the Farmer :

1.—To afford the Recorder board and lodging for one night each month, and where necessary, to convey him and his equipment to and from the nearest station, or the farm before or after in the order of visitation. The Recorder to arrive at every farm in time for the afternoon milking.

2.—To supply, or assist in supplying an accurate report on the food consumed by the cows.

3.—To aid the Recorder, where necessary, in his work of weighing the milk of each cow evening and morning.

4.—To aid the Recorder, where necessary, in obtaining representative samples of milk from each cow, evening and morning, and of the mixed milk.

5.—To give particulars, where possible, as to the breed, age, number of calves, dates of calving, service, and drying-off of each cow, also any other details which may aid in explaining any noteworthy occurrence.

By the College :

1.—To give the farmer a monthly report as to the yield and quality of the milk produced by each cow on the evening and morning included in the visit of the Recorder. This report also to state the total yield of the herd on the evening and morning, and thus afford a check on the production of other days.

2.—To give the farmer an annual report as to the yield and quality of the evening and morning milk produced by each cow in the herd. This report to be based on the figures obtained at the monthly visits.

3.—To give the farmer a six-monthly and annual report as to the total cost of the various foods consumed by his herd, as calculated from the monthly food returns.

4.—To give information and advice as to the properties of new foods or the compounding of rations.

5.—To send to the farmer a copy of all printed reports on the results of the investigation. In such reports the farms to be designated by a letter or number

6.—The College to supply the milk-weighing outfit, and the bottles necessary for all samples of milk.

The details of this scheme were also explained and discussed at the annual meeting of the Surrey and West Kent Milk Producers' Association, held at Redhill, in November, 1911, with the result that a group of twenty-two farmers was formed to co-operate with the College in the investigation during the winter months. After three months all but two of the co-operating farmers agreed to continue the work throughout the year, thus enabling information to be collected on the cost of food in the production of milk during summer, and adding greatly to the scope and value of the investigation from all points of view.

The visits of the Recorder commenced in the last week of December, 1911, and were continued, as nearly as possible, at monthly intervals throughout the following year. For this work the College were able to secure the services of Mr. R. G. Chandler, and the success of the practical side of the investigation is very largely due to the tact, energy, and whole-hearted enthusiasm which he displayed in the discharge of his duties.

The thanks of the College are also due to the following farmers for their kind hospitality, advice and assistance:—Messrs. L. P. Haynes (East Peckham); W. Hole, H. Gorwyn (Sevenoaks); W. Goodwin, A. Stephens, A. L. Graham (Tonbridge); A. S. Kelly, A. Higgs, (Edenbridge); H. Harker, F. Durman, J. Lyon, J. R. Tafft (Redhill); F. H. Beaumont, J. C. Holm (Betchworth); A. Chalmers (Charlwood); T. W. Broom (Dorking); Jas. Lyon, H. Rose (Guildford); J. M. Kelly (Clandon); J. and W. Dale (Capel); J. Gilbert (Surbiton); and the Horticultural College, Swanley.

PART I.

COST OF FOOD IN THE PRODUCTION OF MILK.

PART I.

COST OF FOOD IN THE PRODUCTION OF MILK.

The information collected on this subject is tabulated and discussed in the following four sections :—

Section A.—Cost during the Winter—January to March.
Section B.—Cost during the Summer—April to October.
Section C.—Cost during the Autumn—November and December.
Section D.—Cost for the complete year.

This division of the subject is the most natural one, being most in accordance with the actual practice of the dairy farmer, though not by any means the simplest or the easiest to present in a concise form. The fact that the winter feeding changes gradually into that of summer, varying in date and in rapidity according to the growth of grass and the supply of mangels and fodder, and that likewise the summer feeding changes gradually into that of winter by the use of increased amounts of cake and meal, maize, cabbages, etc., prevents the division of the year into two clearly marked winter and summer periods. As a rule this transition stage is much shorter in spring (often covering only a few weeks) than in the autumn, when it may extend from September to the end of November or later, the length of the period of change varying greatly from year to year.

In the year under consideration (1912), several farms in West Surrey had the advantage of very early spring grass, also, owing to the scarcity of roots and fodder following the short crops of 1911, farmers were turning out their cows at the earliest possible opportunity ; other farmers again suffered somewhat by reason of the drought in April and May, while all of them benefited by the moist and mild autumn, which gave a supply of grass and allowed cows to be kept out at nights to a later date than is usually the case.

These varying factors make it a difficult matter to interpret correctly the figures for any farm or group of farms for any single part of a year, and show the advisability of having

results extending over a complete twelvemonth; even then difficulties arise, as the crops—good or bad—of one year may materially affect the cost of feeding in the succeeding year, and a correct view of the relationship between the seasons and crops on the one hand, and the cost of milk production on the other, can only be obtained by continuing such an investigation over a period of years.

Section A.—Cost during the Winter—January to March, 1912.

During these three months the cows were entirely dependent on indoor feeding, and every care was taken to have the weights and prices of the foods as accurate as possible. At the end of the period each farmer had submittted to him a statement of the cost and composition of the ration used on his farm, and any corrections by him as to the cost of cakes, meals, etc., were at once made.

VALUATION OF THE FOODS USED.—All purchased foods were charged at the cost price, plus an allowance for cartage to the farm, while home-grown grain was taken at the farmer's own estimate. The bulky foods were charged at the following average prices per ton, these being the same as were used in the previous report:—

Mangels and Swedes	10s.	per ton.
Turnips	8s.	,,
Hay	60s.	,,
Oat Straw	40s.	,,
Barley Straw	25s.	,,

The majority of the farmers in the group agreed that such home-grown crops should be charged to the cows at the *cost of production* only, *not at market price*, and that the above prices were fair averages, considering the variations in crop and labour from year to year.

The facts that mangels and hay would make 20s. and 90s. per ton respectively in the nearest market town, or on the farm in rare cases, are not sufficient reasons for charging them at these prices to the cows, as it is obvious that if all the mangels and hay in the county were exposed for sale such prices could not be realised. The average dairy farmer cannot sell his mangels and hay at the above prices and thus get a

direct profit; he has instead to get his profit indirectly by means of the milk these crops produce when fed to his cows, and if these foods were charged at market price he would be assuming the obtaining of a direct profit which his actual method of using the crops renders impossible.

The acceptance of the principle that home-grown foods should be charged to the cows at a price representing the cost of production also obviates any difficulty as regards the quality of hay or straw. There is a tendency on the farmer's part to charge inferior or weathered hay at a lower rate, though such hay has probably cost more in labour than that obtained under better conditions; but labour has been expended on the crop independent of the quality of the produce obtained, and when such hay is fed to cows it must be charged at the average price. It is frequently the case that unseasonable weather makes a poor crop of mangels or hay cost more per acre or per ton than a first-class crop costs in a good season.

The foregoing prices are undoubtedly open to criticism, and are not by any means applicable to all districts, but until actual costs of production per acre over a series of years are available, such averages agreed on by practical farmers in the district must form the basis of all calculations of cost of feeding.

The foods fed to dry or fattening cows were not taken into account, as it was considered that the value of the calf or the fat cow would on the whole balance the cost of foods used when the cows were dry.

Method of Calculation.—The quantity of milk produced in the twenty-four hours covered by the Recorder's visit was taken as the average daily yield and used to calculate the total number of gallons produced per month; this total, together with the calculated cost of food for the same period, and the number of cows in milk, supplied the data for the determination of

(*a*) Average daily yield per cow.
(*b*) Average cost of food per cow per day.
(*c*) Average cost of food per gallon of milk.

These three results were calculated for each farm for the three months of full winter feeding, and the averages for the

Table I.

Results from Twenty Farms.

Averages for January, February and March.					Average Daily Rations for Jan., Feb., March.				
Farm.	No. of Cows in Milk.	Daily Yield per Cow.	Cost of Food per Cow per day.	Cost of Food per Gallon of Milk.	Roots.	Hay.	Straw.	Wet Grains.	Cakes and Meals.
		gallons.	pence.	pence.	lbs.	lbs.	lbs.	lbs.	lbs.
T	8	2.66	12.0	**4.50**	25	6	11	12:20	3:4
E	34	1.99	9.9	**4.99**	56	5	6	34	—
H	27	1.95	10.3	**5.25**	0:14	13	—	15:25	6:8
Q	60	2.26	12.8	**5.66**	56	4:8	13:2	—	8:12
M	52	2.43	13.9	**5.71**	42	13	—	14:20	8:11
J	59	2.41	14.4	**5.95**	63	7	9	38	2:3
P	44	1.99	12.0	**6.08**	65:46	8	12:0	—	8:3½
I	22	2.01	13.6	**6.79**	29	7½	10	13	8½
K	29	1.84	13.0	**7.05**	62:56	11	5	—	6:8½
O	25	2.25	16.5	**7.31**	26	21	14	—	8
F	37	2.08	15.5	**7.49**	60	13	12:18	—	7½
L	25	1.92	14.6	**7.61**	40:100	9	9	21:0	5:11
A	22	2.24	17.2	**7.66**	65	4½	16	—	15:10
D	22	2.01	15.5	**7.70**	45:40	16:0	0:16	34	5:3
B	44	2.13	16.7	**7.85**	54:74	7½	10	16:8	8:9½
N	63	2.06	16.5	**8.02**	61	7½	6	33:15	12:7
R	52	1.97	16.0	**8.13**	60	15	10	—	10:8
C	34	2.00	16.6	**8.27**	26	26	5	16	4½
S	37	1.91	16.4	**8.61**	60	12	12	20	4½
G	34	2.03	18.7	**9.21**	84:48	25:20	—	40	3
Averages ..		**2.11**	**14.68**	**6.96**					

period are given in the table on p. 28. The average daily rations used on each farm during the same period are also given.

(It must be clearly understood that the costs in this and other sections refer only to the cost of the food consumed by the cows, and do not in any case include the cost of labour on the cows or in the delivery of milk, cost of litter or insurance, or any allowance for depreciation, or interest on capital.)

An examination of the costs of food per gallon of milk as tabulated above shows that

2	farms	produced	milk	at	less than 5d.	per gallon.
4	,,	,,	,,	,,	from 5d. to 6d.	,,
2	,,	,,	,,	,,	,, 6d. to 7d.	,,
7	,,	,,	,,	,,	,, 7d. to 8d.	,,
4	,,	,,	,,	,,	,, 8d. to 9d.	,,
1	farm	,,	,,	,,	,, above 9d.	,,

The average cost of food per gallon of milk was 6.96d., and it is noteworthy that on twelve out of the twenty farms the cost of production was above the average ; on the nine farms where the cost exceeds 7½d. per gallon for food only, the production of milk during the winter period can hardly have been carried on at a profit. In the winter period of 1911-12 there was a great shortage of roots and fodder, owing to the drought during the previous summer, and many feeding stuffs were at very high prices, hence the cost of feeding could only be expected to be higher than in previous years (see page 16), but at the same time it should have been possible to produce milk on almost *every farm* at a cost for food of *not more than 7d.* per gallon, while the average for a group of farms should have been *distinctly lower.*

In the above table it is evident that the low costs per gallon are not always associated with the cheap daily rations, or with the high daily yields, and in the absence of any general relationship between these points the following notes on the yields and rations of some of the farms will assist in interpreting the figures for the period.

Causes of the Low Costs per Gallon—Farms T to P.

Farm T.—In this case it is evident that the cause of the low cost of production is the very high daily yield per cow,

and in this connection it must be kept in mind that in a small herd such as this (eight to nine cows) it is much easier to have a high average yield than in a large herd. The cost and amount of the daily ration is surprisingly low considering the milk yield of the cows, and probably indicates careful buying of foods, close attention to feeding, and the possession of a few cows which are very economical producers. As the ration used was distinctly below the scientific requirements as regards quantity of starch equivalent and protein,* the results in this case must be looked on as exceptional, and therefore rations with similar proportions of foods cannot be recommended for general use.

Farms E and H.—Here the cause of the low cost per gallon is the cheapness of the daily ration; it is surprising to find that cows are kept during a period of three winter months at a daily cost of only 10d. to 10½d., but it must also be noted that the daily yield per cow is distinctly under the average in both cases. The results obtained for the remainder of the year show that on one of these farms the cows gave the lowest daily yield, while on the other new cows were frequently introduced.

The rations used on these two farms were different; on E no concentrated foods were used, the ration being made up of roots, fodder and wet grains, and although apparently suitable under the local conditions, this ration cannot be recommended for general use, because of the excessive proportion of watery foods. On farm H roots were used in very small quantities, wet grains supplying additional moist food, while the allowance of cakes and meals was satisfactory.

Farm Q.—On this farm the cheap production is evidently due to two causes—the possession of good cows, and careful attention to the feeding. The herd is a typical dairy-breeding herd and the cows in milk were fed according to their production and maintained in a satisfactory condition throughout the year, while the ration was in very close agreement with the scientific recommendations as regards quantity and proportions of nutrients. The system of feeding on this farm is worthy of high commendation, while the keeping of milk

* For details regarding Composition of Rations, see College Bulletin on "Winter Feeding of Dairy Cows," by J. Mackintosh.

records for a number of years and careful use of the information obtained has resulted in a high average standard of production.

Farms M and J.—These two farms can be considered together, as the systems of management and results were similar. Again the heavy yield per cow is chiefly responsible for the low cost per gallon; the daily rations were distinctly above the scientific requirements for the milk produced, but as a partial explanation of this and of the high daily yield per cow it should be mentioned that in both these herds a comparatively large number of cows were bought in milk and sold fat each year.

Farm P.—As the cost per gallon is here almost 1d. below the average, this farm may be included amongst those with a low cost, and this is due to the cheap daily ration which is at the same time proportionate in quantity and quality to the milk yield.

Causes of the High Costs per Gallon—Farms L to G.

At all these farms the cost is too high, ranging from 7.6d. to 9.2d. per gallon, and in every case this is due to the ration being too costly or too heavy considering the milk yield of the cows, or in other words, the cows have not been fed according to their milk yield. This does not mean that all cows, whether giving two gallons or four gallons per day, were fed alike, but that even where it was the custom to allow extra cake or meal to the best milkers, the rations in use were greater than the milk yield of the cows required. On only two out of the nine farms indicated above does the average daily yield per cow equal the average yield of all farms, hence the cost of the daily ration should have been as low, or lower than the general average, instead of being appreciably higher. On farm A the yield is above the average, but the high cost of production here is due to the use of excessive amounts o high-priced concentrated foods; on two of the farms (C and G) the use of large amounts of hay is the chief cause of high costs, while on N and R the allowance of cake and meal is too high considering the quantities of other foods given.

Interesting comparisons may be made between farm P on the one hand, and R and C on the other, and also

farms A and Q, where the daily yields are similar, but the costs of production are very different.

The returns for one farm in this group for each of the three months are given in the following table, and illustrate one of the immediate practical benefits which follow the change from careless to careful methods of feeding.

TABLE II.
SAVING EFFECTED ON ONE FARM.

Month.	Daily Yield per Cow.	Cost per Cow per day.	Cost per Gall. of Milk.
	gallons.	pence.	pence.
January	2.04	17.08	8.36
February	1.95	15.71	8.04
March	2.05	13.55	6.62

RELATION BETWEEN CERTAIN FOODS AND COST OF PRODUCTION

A careful examination of the rations in use at the above farms has failed to show that any one ration or type of ration is definitely related to a low lost of production. Wet grains are often thought to be associated with cheap production, but this is not necessarily the case, for instance, of the six farms producing milk at under 6d. per gallon, Q does not use grains, and of the five producing milk at over 8d. per gallon, all use grains except R, while the one farm (G) producing milk at a cost of over 9d. per gallon used 40 lbs. per cow per day. On the other hand, as noted in the First Report, the use of excessive amounts of hay (15 to 20 lbs. or more per day) is usually associated with a high cost of production; only four of the above farms used 15 lbs. per day or over, and on three of these (R. C. and G) the cost of production per gallon was respectively 8.13d., 8.27d. and 9.21d.

Farmers in general are very apt to think that certain foods or certain rations possess some miraculous power of milk production, but scientific experiment and observation point more and more definitely to the conclusion that, as regards feeding, cheap milk production in winter depends more on attention to the quantity and proportion of the various foods in the ration, than on the purchase of any one particular cake

or meal. It is not sufficient *merely to buy* some favourite or much advertised food ; it is also very necessary to see that a ration is prepared suitable in quantity and quality to the milk yield and other needs of the cows,* and it is also almost self-evident that carelessness on the part of the farmer is sure to be followed by equal carelessness on the part of the cowman.

It has been mentioned regarding the farms F to G, that the high cost of production is due largely to heavy feeding, and one point which has occasionally been raised by farmers in this connection may be briefly discussed here. It is urged that, though the liberal use of cakes and meals increases the cost of production, the cows will improve in value in consequence, and in order to have a complete balance sheet for the herd, this increase in value should be estimated and credited to the foods used in addition to the milk produced ; similarly, any depreciation associated with lighter feeding or cheaper production should be debited against the returns from the herd.

This is undoubtedly quite true, but up to the present it has not been possible to obtain any figures for this rise or fall in value, either by individual valuation of the cows and heifers, or by the increase or decrease in live weight. In the dairy herds consisting chiefly of home-bred stock, or of cows which are expected to breed regularly, these fluctuations in condition and value as a result of feeding will probably not be very great, but on farms where cows are freely bought and sold the proportion of the food used in fattening cows will be considerable, that is, fattening the cows while they are still in milk, for in this investigation only the food fed to cows giving milk has been calculated. Had the number of farms been larger it would have been advisable to divide them into two groups, according to the two systems of management, but almost all the farmers referred to have home-bred or breeding herds.

Reducing the Cost of Production.

Reference has already been made to the saving effected on one farm by drawing attention to the amount and cost of the daily ration. When the results from all the farms are stated in monthly averages, this possible reduction in cost without materially affecting the yield, is again illustrated.

* *See* College Bulletin on "Winter Feeding of Dairy Cows."

TABLE III.

AVERAGES FOR JANUARY, FEBRUARY AND MARCH, 1912.

Month.	No. of Farms.	Daily Yield per Cow.	Cost of Food per Cow per day.	Cost of Food per Gallon of Milk.
		gallons.	pence.	pence.
January	20	2.12	15.43	7.26
February	20	2.07	14.56	7.01
March	20	2.12	14.06	6.63

The above table shows that by March the cost of food per gallon of milk was reduced .63d. below that of January. While this fraction of a penny per gallon appears a small thing in itself it represents a saving of between £130 and £140 to the group of farmers in the space of three months.

COMPARISON OF RESULTS IN FIRST AND SECOND REPORTS.

In the first report on this investigation, published in December, 1910, the averages for the daily yield per cow, cost of food per cow per day, and cost of food per gallon of milk were worked out on the returns obtained by one visit to each of sixty farms, while on this occasion averages for the same points are based on three visits to each of twenty farms during the corresponding season of the year. Table IV. shows the results obtained in each case.

TABLE IV.

COMPARISON OF RESULTS IN FIRST AND SECOND REPORTS

	Daily Yield per Cow.	Cost of Food per Cow per day.	Cost of Food per Gallon of Milk.
	gallons.	pence.	pence.
First Report, 1910	2.24	14.88	6.58
Second ,, 1912	2.11	14.68	6.96

The figures for the daily cost of feeding a cow in milk are very similar and undoubtedly represent the actual average cost in Surrey and West Kent. The yield per cow is slightly less in 1912 than in the previous winters, and this is reflected in the increase in the cost per gallon of milk. It is highly probable that the exceedingly hot and dry summer of 1911 is largely

responsible for this drop in yield during the ensuing winter months, although the reduction in the number of farms visited may also have contributed to this result. On the whole, therefore, the results obtained in 1912 confirm the accuracy of those obtained in the previous investgiation.

Section B.—Cost during the Summer—April to October, 1912.

The difficulty of arriving at a satisfactory summer period, owing to the gradual nature of the changes from winter to summer feeding, and *vice versa*, has already been referred to. The method ultimately adopted was decided on after consultation with many of the farmers interested, and appeared to meet most of the circumstances, though the experience of collecting and working out the results has shown the necessity for slight alterations.

METHOD OF ESTIMATING COST OF PRODUCTION.

It was agreed to fix on a period of twenty-four weeks as representing that of summer feeding, to estimate the cost of all the foods consumed during this period, and by means of the milk records for the same time, work out the cost of food per cow and per gallon of milk.

When the food records for October were received and examined, it became evident that it would be more accurate to lengthen the summer period to twenty-eight weeks, as during that month there was still a good supply of grass. To retain the twenty-four weeks period as a basis of calculation would have made the costs of production for October distinctly lower than was actually the case, as no grass could be charged for, while the summer costs would have been too high to a corresponding degree. In 1912, therefore, the total value of the pasture and aftermath is spread over a period of twenty-eight weeks, but in other years it is probable that a twenty-six weeks period would be equally satisfactory, and perhaps this period could, if desirable, be made to coincide with that of the summer milk contract.

VALUATION OF THE FOODS CONSUMED.—The value of foods consumed during the period was estimated under the following heads.

1. *Pasture*—calculated from the acreage grazed by the cows and the value or rent per acre; the value was placed higher or lower than the rent, according as the quality of the pasture varied above or below the average for the farm.
2. *Aftermath*—valued at 15 per cent. to 20 per cent. of the rent per acre, and calculations based on this figure and the acreage grazed by the cows.
3. *Soiling Crops*—charged to the cows at the estimated cost per acre for cultivations, manure, seed, cutting and carting, rent, rates, etc.
4. *Cakes, Wet Grains, etc.*—calculated from the cost price and the quantities fed to the cows as obtained by the Recorder at each monthly visit.

After the close of the summer period a report was sent to each farmer, showing in a concise form the acreages and values of pasture, aftermath, soiling crops and concentrated foods used on his farm, together with the calculated cost per cow, and per gallon of milk, and any alterations as to acreage or value were at once made. In this way it was ensured that each farmer considered the costs fair and accurate for his own farm, while he also obtained a basis for comparison in future years, and a valuable guide as to the relative advantages of winter and summer milk production.

THE INFLUENCE OF LOCAL CONDITIONS ON COSTS.

During the winter period the bulky foods—roots, hay and straw—were charged at the same price per ton on each farm, but it was not advisable to follow the same method in the case of grass and charge it at a uniform rate per acre, per week or per cow for the following reasons.

The quality of the pasture varied very much, and this of course influenced the amount of the rent, but in certain cases the proximity of a farm to a town had the effect of raising the rent to a higher figure than would have been the case in other situations. Farms close to towns usually had a smaller acreage of grazing land per cow, and in addition grew soiling crops—rye, trifolium, tares and maize—for summer feeding, and used large quantities of concentrated foods. Such farms are greatly handicapped in the production of cheap milk in summer, but most probably have a corresponding advantage in the slightly

larger milk yield, reduction in cost of carriage, and the higher price obtained. There may also be cases where grass land, which a few years ago was in poor condition and obtained at a low rent, has been improved by judicious manuring, and although some residual value may be charged annually, the profit on the manures is now being obtained in the cheaper production of milk. Some farms also may have the majority of the cows calving in the autumn and thus have a large percentage of dry and stale cows towards the end of the summer with a low average daily yield and consequently a high cost per gallon.

It might be possible to calculate the value of the pasture and aftermath at so much per cow per week, but this figure would have to vary with the quality and extent of the pasture and the number of cows grazed, in order that the total for the summer should correspond with the actual annual rent paid for the land. At the same time the adoption of a weekly or monthly charge for grazing, with a sliding scale in spring and autumn, would make it possible to take better account of the gradual changes in the feeding during these seasons. In this way an estimate of the cost of feeding and production for each month of the year might be obtained, but until further attempts have been made it will scarcely be possible to say which is the best method for estimating the cost of food in the production of summer milk.

It will now be evident that the figures given in this section should be studied simply as the results from the first attempt to gain information as to the costs of milk production during summer, and that, with a few exceptions, it is impossible to state the causes of the high and low costs with the same accuracy as in the case of winter production.

Table V., on page 38, shows the average yields and costs during the summer period on twenty farms, and in order to aid in the interpretation of the results, columns are included, showing how the cost of summer feeding is divided amongst pasture and aftermath, soiling crops and purchased foods.

Causes of Low Cost of Production.

Farms D and I.—The most apparent cause of the low cost of production on these farms is undoubtedly the posses-

TABLE V.

RESULTS FROM TWENTY FARMS.

AVERAGE OF THE SUMMER PERIOD OF TWENTY-EIGHT WEEKS— APRIL TO OCTOBER, 1912.

Farm.	No. of Cows in Milk.	Daily Yield per Cow.	Cost of Food per Cow per day.	Cost of Food per Gallon of Milk.	Percentages of Summer Cost.		
					Pasture and Aftermath.	Soiling Crops.	Purchased Foods.
		gallons.	pence.	pence.	%	%	%
D	22	2.15	2.66	1.23	64	—	36
C	31	2.35	3.23	1.37	77	—	23
B	40	2.40	3.74	1.55	60	3	37
I	27	2.09	3.27	1.56	47	—	53
R	46	2.33	5.28	2.27	33	24	43
K	25	2.34	5.40	2.30	55	3	42
E	32	2.27	5.46	2.31	20	11	69
O	24	2.06	4.88	2.36	38	16	46
S	37	2.10	5.00	2.38	54	—	46
P	40	1.92	4.66	2.40	37	—	63
L	36	2.21	5.88	2.65	67	—	33
N	52	2.35	6.24	2.65	33	8	59
J	58	2.27	6.48	2.86	18	7	75
M	52	2.30	6.61	2.87	42	11	47
F	32	2.21	6.43	2.90	55	—	45
G	30	2.22	6.44	2.90	53	9	38
H	33	1.90	5.95	3.12	46	—	54
Q	51	2.47	8.04	3.25	31	18	51
A	24	2.28	8.41	3.61	29	7	64
T	8	2.32	12.48	5.38	17	4	79
Average of all Farms ..		2.24	5.70	2.54			

sion of fairly cheap pasture, which, either by reason of its quantity or quality, did not require to be supplemented by soiling crops, nor by the purchase of large quantities of concentrated foods.

Farms C and B.—Here also the pasture required but little aid in the way of green crops, and only small quantities of cake were bought, but a secondary cause is the good daily yield maintained throughout the summer period.

CAUSES OF HIGH COST OF PRODUCTION.

Farm T.—This farm suffered very severely all the summer through lack of good pasture, and consequently hay, cake and meals had to be largely used, with the result that the cost per cow per day is as high as during the winter period; also a lower average daily yield makes the cost per gallon higher (5.38d. as compared with 4.50d.). The very low cost of production during the winter is, therefore, discounted by the very high cost during the summer.

Farm A.—Here the cause of the high cost is the excessive feeding of cakes and meals throughout the summer, and in this instance there are strong reasons for believing that the pasture and green crops were sufficiently good and abundant to have made this unnecessary; it should have been possible to produce milk on this farm at under 3d. per gallon.

Farm Q.—It is difficult on the figures and information of one year to ascertain the true cause or causes of the high cost on this farm; perhaps the amount spent on soiling crops could be materially reduced in another season, and again, these crops may have been largely responsible for the high daily yield per cow through the summer (2.47 galls.).

Farm H.—In this case the low daily yield (1.90 galls.) is the main cause of the high cost; it should be easily possible for a herd of cows to average at least two gallons per day during the summer.

The figures from the other farms do not lend themselves to the formation of any general conclusions, though in particular cases, the farmer with his local knowledge as to how he was affected in 1912 by the season, prices of feeding stuffs, etc., will be able to make alterations in subsequent years, which will result in cheaper production.

Section C.—Cost during the Autumn—November and December.

During the earlier part of this period there was still a small amount of grass available; sufficient on a number of farms to delay the commencement of full indoor feeding till late in the season, and as this grass has already been charged for in the summer period, the costs for November are some what lower than that of full winter feeding.

In Table VI. the average costs and yields for each of the two months are stated, illustrating in a general way how the cost of production increased as the season advanced. (As one farmer sold his cows in the autumn, the averages are compiled from the returns of nineteen farms.)

TABLE VI.

AVERAGES FOR NOVEMBER AND DECEMBER, 1912.

Month.	No. of Farms.	Daily Yield per Cow.	Cost of Food per Cow per day.	Cost of Food per Gallon of Milk.
		gallons.	pence.	pence.
November	19	2.06	11.46	5.55
December	19	2.04	12.31	6.04

Table VII. shows the individual averages for each of the nineteen farms over the two months of November and December. Owing to the varying amount of grass available and the consequent frequent changes in the quantity and character of the foods given, a statement of the daily ration is not included in this table.

CAUSES OF LOW COST OF PRODUCTION.

Farms C and R.—On both these farms it was apparently possible to postpone the use of a full allowance of concentrated foods and hay till late in the season, and this accounts for the low cost per gallon.

Farm E.—Here the chief cause is the high daily yield during the two months, and this yield is probably due to the introduction into the herd of a large proportion of newly-calved cows.

Farm B.—In this case the low cost of production appears to be due to a combination of a fairly high daily yield with a cheap daily ration.

TABLE VII.

RESULTS FROM NINETEEN FARMS.

AVERAGE OF THE TWO MONTHS—NOVEMBER AND DECEMBER, 1912.

Farm.	Number of Cows in Milk.	Daily Yield per Cow.	Cost of Food per Cow per day.	Cost of Food per Gallon of Milk.
		gallons.	pence.	pence.
C	32	2.03	7.86	3.86
E	32	2.65	11.39	4.29
R	54	2.17	9.39	4.33
B	43	2.27	10.81	4.75
Q	59	2.26	11.77	5.19
O	21	2.36	12.31	5.20
I	33	1.70	8.83	5.21
J	55	1.95	10.25	5.26
T	8	2.39	13.10	5.48
M	49	2.19	12.16	5.56
H	33	1.70	9.49	5.57
K	32	1.91	11.11	5.81
N	53	2.18	13.60	6.23
L	26	1.98	13.27	6.70
D	24	1.57	11.02	6.99
P	46	1.77	12.90	7.25
S	37	1.86	15.23	8.18
A	23	2.33	19.77	8.49
F	39	2.00	17.01	8.51
Averages of all Farms		**2.05**	**11.90**	**5.80**

CAUSES OF HIGH COST OF PRODUCTION.

Farms F, A and S.—On all these farms the cost of the daily ration appears excessive, and when this is associated with comparatively low daily yields per cow on farms S and F, the cost of food in producing a gallon of milk reaches an unprofitable figure. On farm A, the daily yield is well above the average of all the farms for the period, but is not a sufficient reason for feeding a ration costing 19d. per day.

Section D.—Cost for the Complete Year—1912.

In this section little more can be done than present the results for the complete year. In the previous sections the most apparent causes of low and high costs of production were considered, and as these causes likewise affect the final result further detailed comments are unnecessary, also until the figures for another year are obtained no comparisons can be made. In Denmark and Sweden various Control and Cow-testing Societies have published results for eight or more consecutive years, showing a gradual increase in the annual yield per cow, and also a gradual decrease in the cost of production, but as yet similar returns for Societies or Counties in England are not obtainable.

Table VIII. shows a summary for the year according to the periods into which it was divided, also the average daily yield, cost per cow and cost of food per gallon of milk for the complete twelve months.

TABLE VIII.

SUMMARY FOR THE YEAR—1912.

AVERAGES ACCORDING TO PERIODS—WINTER, SUMMER AND AUTUMN.

Period.		Daily Yield per Cow.	Cost of Food per Cow per day.	Cost of Food per Gallon of Milk.
		gallons.	pence.	pence.
Winter	January to March	2.11	14.68	6.96
Summer	April to October	2.24	5.70	2.54
Autumn	November, December	2.05	11.90	5.80
For 12 months		2.17	9.37	4.32

The above figures bring out one point worthy of attention, viz., the notably lower cost of production at the end of 1912 than in the months of January, February and March. This is certainly partly due to the postponing of full winter feeding to a late date, partly to the lower prices in the case of certain bought feeding stuffs, and on a number of farms, perhaps increased attention to the feeding of the cows has also contributed to a decrease in the cost.

At the same time it must be remembered that a complete comparison will only be possible when the figures for January to March, 1913, are available. In order to have strictly comparable winter periods, it would be advisable to have the twelvemonths commencing and ending at Michaelmas.

Table IX. shows the averages for the year for each of the nineteen farms completing the period.

The average daily yield per cow for the year is shown to be 2.17 gallons. On three farms the cows averaged under 2 galls. per day, and this cannot be regarded as satisfactory. The highest average is in the small herd on farm T (2.43 galls. per day), and the next is in the large herd on farm Q (2.37 galls. per day).

Two farms have fed the cows at an average cost of over a shilling per day throughout the year; on one of these (T) this is the result of a dry spring and poor grazing land, with a consequent large purchase of cakes and meals, while on the other (A) similar large amounts of concentrated foods were bought without the same apparent necessity.

The average cost of food per gallon of milk for the year is 4.32d., and as only seven of the nineteen farms exceed the average it is most probable that greater economy and attention to feeding on these farms would cause the average to drop to 4d. per gallon.

General Conclusions.—A careful study of the foregoing results, followed by a comparison with those obtained from their own herds, cannot fail to be of interest and benefit to many dairy farmers, but caution should be observed in copying, either for winter or summer, any of the rations or methods of feeding stated above.

When deciding how to feed a dairy herd for any season, the amount of home-grown foods, the price of cakes and meals,

TABLE IX.
RESULTS FROM NINETEEN FARMS.
AVERAGES FOR THE YEAR—1912.

Farm.	Average No. of Cows in Milk.	Daily Yield per Cow.	Cost of Food per Cow per day.	Cost of Food per Gallon of Milk.
		gallons.	pence.	pence.
E	33	2.32	7.82	3.37
I	27	1.99	6.86	3.45
C	32	2.19	7.98	3.64
D	22	2.01	7.68	3.82
B	42	2.30	8.83	3.84
H	32	1.88	7.61	4.05
K	27	2.13	8.74	4.09
M	51	2.31	9.58	4.13
J	58	2.24	9.39	4.18
R	50	2.19	9.25	4.22
Q	55	2.37	10.17	4.28
O	24	2.17	9.35	4.31
P	43	1.91	8.33	4.34
L	26	2.10	9.60	4.57
N	55	2.23	10.72	4.80
S	37	2.00	9.87	4.91
T	8	2.43	12.47	5.13
F	35	2.13	11.30	5.31
A	23	2.27	12.70	5.57
Average of all Farms		2.17	9.37	4.32

the position of the farm as regards a station, etc., all have to be considered, and because of the variation in these conditions the same ration might differ materially in price from farm to farm, and from year to year. Also, it is desirable that a farmer should study and discuss his local conditions, and plan his own method of feeding, instead of simply adopting the ration which another farmer has found satisfactory—the ration which is best and cheapest for one farm is not necessarily the best and cheapest for every other farm.

With regard to summer feeding, the information obtained goes to show that local conditions exercise so much influence on the cost that the comparison of one farm with another is of little value. When returns for future years are obtained and it is possible to compare one year with another on the same farm, many important facts will be brought to light and the farmer will be able to select the method of summer feeding which is shown to be most economical.

In the case of winter milk, the results obtained throughout this investigation show that the cost of food per gallon averages 6½d. to 7d. (see p. 34). *As a few of the farmers can produce it at from 5d. to 6d. per gallon, there seems no reason why in the course of a year or two the average over a similar group of farms should not be 6d.* (i.e., *equivalent to having a herd averaging 2⅓ gallons per day, and receiving a daily ration costing 14d*).

From every point of view such a reduction is highly desirable, and while the actual method which will bring about this result will vary from farm to farm—in some cases the average yield from the cows will have to be materially increased, and in others the buying and feeding will have to be done more economically—the immediate and continued attention to the following points cannot fail to enable many dairy farmers to improve their herds and increase their annual returns.

I.—The keeping of accurate records of the milk yield of every cow.

II.—The calculation of the cost of feeding.

III.—The elimination of unprofitable cows.

IV.—The selection of a properly balanced ration, and the feeding of all cows according to their milk yield.

V.—The growing of home-grown foods in sufficient quantity as cheaply as possible.

VI.—The purchase of concentrated foods by the best business methods.

VII.—Careful supervision by the farmer himself.

PART II.

THE MILK RECORDS OF THE VARIOUS HERDS.

PART II.
THE MILK RECORDS OF THE VARIOUS HERDS.

THE INTERPRETATION OF THE FIGURES.

The figures on which this Report is based are collected from a round of twenty farms visited once a month throughout the year 1912 by our Recorder. The total number of cows which came under observation was 1,112, but in some cases, Herd J for example, quite a large proportion of the cows which were in the herd in January were sold during the year and replaced. In the Milk Records such herds, in which cows are bought newly-calved and sold out fat as they dry off, naturally show up better than the herds in which the cows are regularly bred and which contain a fair proportion of heifers. It would therefore be advisable, before studying the Milk Records, to examine the composition of the different herds, their size, the ages of the cows composing them, and the number that has been sold and replaced during the year, and this information is given in Table X. on the next page.

It will be seen from this table that out of a total of 1,112 cows under observation, 224 (20 per cent.) have been sold during the twelve months—in other words the farmers composing the group replaced a fifth of their cows during the year, and from this it may be inferred that the average life of a cow in the milking herd is five years; after that she is sold. In some cases, Herds J and M for example, the average life of the cow in the milking herd is only three years, and the milk yield may consequently be expected to be high. (Compare with Table XI., p. 60.) On the other hand, in the case of Herds F, I and K, where the average life of the cow in the milking herd is nine years, a lower milk yield may reasonably be expected.

Then again, herds with a large proportion of heifers, such as Herds G, I and K, where the heifers constitute about 40 per cent. of the whole herd, must be expected to show a lower milk yield than herds with a small proportion of heifers, such as Herd J (4 per cent.) and Herd E (9 per cent.), and if the

TABLE X.
THE COMPOSITION OF THE VARIOUS HERDS.

Herd	Total Cows in Herd	Cows Sold during Year	1st Calf Cows	2nd Calf Cows	3rd Calf Cows	4th Calf Cows	5th Calf Cows	6th Calf Cows	7th Calf Cows	8th Calf Cows	Doubtful Age
A	39	8	5	1	11	8	6	2	1	2	3
B	69	15	22	12	13	11	6	2	2	0	1
C	40	6	6	10	9	8	0	5	1	1	0
D	32	5	9	3	3	8	3	2	1	0	3
E	54	14	5	13	14	11	4	3	1	0	3
F	57	6	13	10	10	8	3	4	1	1	7
G	39	4	15	8	3	1	2	0	0	0	10
H	60	11	16	16	6	8	5	2	0	0	7
I	47	5	20	4	8	4	4	1	1	0	5
J	78	25	3	10	30	22	8	2	0	0	3
K	38	4	15	7	3	3	3	3	3	1	0
L	39	5	11	6	2	5	1	0	2	1	11
M	96	31	17	23	22	19	6	2	2	1	4
N	76	16	15	11	19	12	13	3	1	0	2
O	41	7	6	5	6	6	2	3	2	0	11
P	67	13	23	12	6	7	8	1	1	1	8
Q	84	18	16	15	13	11	11	11	2	2	3
R	78	15	15	8	11	11	2	3	12	7	8
S	69	17	13	23	17	11	3	1	1	0	0
T	9	0	1	3	2	0	1	1	1	0	0
Totals	1112	223	246	200	208	174	92	51	35	17	89
Percentage of the Herd			22	18	18	16	8	5	3	2	8
Average Yield of Milk in galls.			493	590	662	707	706	688	735	705	

actual figures do not bear out these expectations it is all the more credit to the owners. All these considerations must be borne in mind when comparing the milk yield of one herd with that of another. The proportion of heifers in an average milking herd appears to be about 22 per cent., 246 out of the 1,112 cows under investigation being first-calf cows.

The average milk yields of the differently aged cows inserted at the bottom of Table X. are interesting in showing that the seventh and eighth-calf cows have given as much or even more milk than the fourth and fifth-calf cows. The reason for this is no doubt that cows of this age are only kept in the herd when they are particularly good ones. The figures are, therefore, misleading, because they do not represent *average* seventh-calf and eighth-calf cows, but *very special* ones, and it must not be inferred that an eighth-calf cow may normally be expected to yield better than a fourth-calf cow. The rest of the figures bear out practical experience in showing a considerable increase of milk—97 gallons—in the case of second-calf cows, and a smaller increase up to the fourth-calf, when the yield has usually attained its maximum.

Methods of Stating Milk Yields.

Numerous methods have been used in the past in stating the milk yields of cows, but up to the present no single method has so commended itself as to be universally adopted. Generally speaking, the present methods do not give all the information which it is desirable one should have in order to interpret correctly the performance of any cow.

The quantity and quality of the milk yielded by any cow is affected not only by her age, but also by the length of the period of rest before calving, the date of holding to service, and the season of the year when she calves, and a Milk Record Table should as far as possible give information on these points. Dairy farmers, when buying cows, or calves from cows with stated records, should not be content with the simple statement that a cow has given 800 to 1,000 gallons, but should learn the conditions under which the record was made Breeders and others who are most careful in supplying this information will make their records more reliable and their herds more valuable.

The cow which is most profitable to the average dairy farmer is the one which produces 800 to 1,000 gallons of milk (or more) and a calf each year for a number of years, remaining at the same time in good health and satisfactory condition. The milking period should extend to forty to forty-four weeks and thus allow the cow a rest of twelve to eight weeks before the next calving, so that her constitution may be strengthened and that she may get into fair condition. It is now established that cows in good order at calving will yield milk slightly richer in butter fat for the first six weeks or so in milk than would be the case if they calved down in poor condition.

Dairy farmers who are more concerned in the production of the maximum quantity of milk than in the possession of a well-regulated breeding herd occasionally try to extend the milking period of a cow by delaying the time of service, and cows treated in this fashion will give a larger milk yield, but at the expense of the breeding function. While this method may pay under exceptional circumstances it cannot be recommended for universal adoption, as any practice which is likely to reduce the future number of heavy-milking cows can only result in harm to the dairy farmer. It is at present a sufficiently difficult matter to get heavy milking cows to breed regularly, or to obtain enough young stock from such cows, and any practice which will aggravate these difficulties should be discouraged as much as possible.

Method Adopted in this Report.

After a prolonged consideration of the points mentioned above, the method of tabulation presented in the following pages was arrived at. A period of twelve months is taken as the basis (in this case from January 1st to December 31st, 1912), and the performance of each cow which was in the herd at the end of the year is shown in full. The first column gives the name or number of the cow; the second, third and fourth columns show the lactation period of the cow at the beginning of 1912, the number of weeks in milk and the quantity of milk belonging to that period; the fifth column states the number of weeks dry before the next calving, while the next three columns state the lactation period, weeks in milk, and yield of milk for the remainder of the year. As the year

commenced on January 1st, 1912, the statement of the weeks in milk and weeks dry also indicate the season of the year when the cow calved. The "Weeks dry" column immediately preceding the "Records for the year" shows whether the cow was in milk at the end of the period or the number of weeks she had been dry. When similar tables are prepared for 1913, and succeeding years, it will then be possible to follow out the complete history of a cow—the number of calves, the length of the lactation periods, and the yields of milk and also the number of weeks dry between each calving.

In filling up the "Records for the year" (figures in heavier type), only the records of those cows which have completed a full year in the herd, or whose record represents a complete lactation period (with a few exceptions where cows have been in milk forty weeks or so) have been carried across and utilized for working out the herd average.

The record of every cow under observation has been sent to the farmers concerned, but it would be tedious to present in print the records of the whole 1,112 cows. Cows which have been sold during the year or have been rearing calves during an appreciable period of the time under review, have therefore been eliminated as being of little general interest.

The number of cows whose records are printed in the following pages is thus reduced to 912.

HERD A.

No. or Name o Cow	Lact. Period	Weeks in Milk	Yield of Milk	Weeks Dry	Lact. Period	Weeks in Milk	Yield of Milk	Weeks Dry	Records for the Year		
									Weeks in Milk	Yield of Milk	Percentage of Fat
			galls.				galls.			galls.	
34 Tulip	—	—	—	—	1st	31	268	In milk	—	—	4.2
Fancy	—	—	—	—	,,	26	530	,,	—	—	3.8
20 Betty ..	1st	26	222	13	2nd	13	283	,,	39	505	3.8
4 Beauty ..	—	—	—	—	3rd	39	609	13	39	609	3.7
11 Black Bess	—	—	—	—	,,	39	749	13	39	749	3.2
13 Curly ..	—	—	—	—	,,	39	651	13	39	651	3.7
Snowdrop ..	—	—	—	7	,,	31	603	13	31	603	3.6
3 Daisy ..	3rd	22	251	13	4th	17	415	In milk	39	666	4.0
14 Lemon ..	,,	4	39	26	,,	22	463	,,	26	502	3.4
16 Spark ..	,,	26	266	22	,,	4	77	,,	30	343	3.5
23 None Such ..	,,	4	35	35	,,	13	292	,,	17	327	3.9
32 ..	—	—	—	—	,,	9	217	,,	—	—	4.2
2 Cherry ..	—	—	—	—	,,	43	851	9	43	851	3.1
12 Frisky ..	—	—	—	—	,,	43	772	9	43	772	3.6
Nimble ..	—	—	—	5	,,	30	399	17	30	399	4.2
5 Bramble ..	4th	43	842	5	5th	4	138	In milk	47	981	4.0
6 Cowslip ..	,,	22	270	4	,,	26	499	,,	48	769	3.5
9 Harebell ..	,,	13	218	9	,,	30	504	,,	43	722	3.1
35 Splendour ..	—	—	—	22	,,	26	404	4	26	404	3.1
10 Nancy ..	5th	13	160	18	6th	21	480	In milk	34	640	3.3
18 Red Croydon	,,	8	89	18	,,	26	662	,,	34	751	3.2
36 Red Rose ..	—	—	—	21	,,	31	487	,,	31	487	3.4
37 Dewdrop ..	—	—	—	22	,,	30	449	,,	30	449	3.5
22 Darkie ..	—	—	—	—	7th	43	699	9	43	699	3.5
Pansy ..	—	—	—	4	8th	31	675	17	31	675	3.1
33 Bright Eyes	—	—	—	—	,,	22	214	9	—	—	5.2
Damsel ..	—	—	—	—	?	52	640	In milk	52	640	4.9
Violet ..	—	—	—	13	?	39	780	,,	39	780	3.3
Average for 24 Cows and Heifers in the Herd throughout the year, or completing one Lactation Period									36	624	3.7

HERD B.

No. of Cow	Lact. Period	Weeks in Milk	Yield of Milk	Weeks dry	Lact. Period	Weeks in Milk	Yield of Milk	Weeks dry	Records for the Year: Weeks in Milk	Records for the Year: Yield of Milk	Records for the Year: Percentage of Fat
			galls.				galls.			galls.	
52 ..	—	—	—	—	1st	35	531	In milk	—	—	4.2
53 ..	—	—	—	—	,,	35	443	,,	—	—	3.7
54 ..	—	—	—	—	,,	31	328	,,	—	—	4.5
55 ..	—	—	—	—	,,	22	180	,,	—	—	3.9
56 ..	—	—	—	—	,,	30	391	,,	—	—	3.9
10 ..	—	—	—	—	,,	22	254	,,	—	—	5.5
14 ..	—	—	—	—	,,	23	353	,,	—	—	3.7
2 ..	1st	17	174	13	2nd	22	463	,,	39	637	3.6
16 ..	,,	13	108	22	,,	17	406	,,	30	514	3.5
19 ..	,,	26	325	13	,,	13	364	,,	39	689	3.5
32 ..	,,	26	261	9	,,	17	463	,,	43	724	3.9
33 ..	,,	17	208	9	,,	26	643	,,	43	851	3.5
6a ..	—	—	—	—	,,	43	849	,,	43	849	3.8
57 ..	—	—	—	—	,,	14	278	,,	—	—	3.7
43 ..	—	—	—	—	,,	23	320	,,	—	—	3.8
37 ..	—	—	—	—	,,	23	345	,,	—	—	3.7
17 ..	—	—	—	—	,,	44	648	8	44	648	3.8
26 ..	—	—	—	—	,,	39	512	13	39	512	4.1
35 ..	—	—	—	—	,,	35	405	17	35	405	3.3
36 ..	—	—	—	—	,,	35	506	17	35	506	3.5
47 ..	—	—	—	9	,,	39	661	4	39	661	4.0
27 ..	2nd	4	11	9	3rd	39	727	In milk	43	738	4.5
39 ..	,,	22	413	8	,,	22	562	,,	44	975	3.3
40 ..	,,	13	131	9	,,	30	384	,,	43	515	3.3
49 ..	—	—	—	—	,,	38	673	,,	38	673	3.4
51 ..	—	—	—	—	,,	38	701	,,	38	701	3.7
11 ..	—	—	—	—	,,	48	966	4	48	966	3.8
23 ..	—	—	—	—	,,	39	762	13	39	762	4.5
24 ..	—	—	—	—	,,	48	823	4	48	823	3.8
44 ..	—	—	—	—	,,	43	736	6	43	736	4.0
13 ..	3rd	26	503	13	4th	13	371	In milk	39	874	3.0
18 ..	,,	26	196	9	,,	17	435	,,	43	631	4.4
30 ..	,,	4	30	9	,,	39	688	,,	43	718	4.4
42 ..	,,	26	371	13	,,	13	402	,,	39	773	3.8
45 ..	—	—	—	8	,,	44	933	,,	44	933	3.7
50 ..	—	—	—	—	,,	35	598	In milk	—	—	3.5
7 ..	—	—	—	—	,,	43	838	9	43	838	3.4
4 ..	4th	4	41	18	5th	30	481	In milk	34	522	5.2
8 ..	,,	31	439	17	,,	4	153	,,	35	592	4.0
9 ..	,,	26	285	9	,,	17	514	,,	43	799	3.8
22 ..	,,	26	210	—	,,	26	320	,,	52	530	6.0
41 ..	,,	9	90	13	,,	30	607	,,	39	697	4.0
15 ..	—	—	—	—	,,	24	648	,,	—	—	3.8
6 ..	—	—	—	—	,,	17	525	,,	—	—	3.3
28 ..	—	—	—	—	,,	35	734	17	35	734	3.4
34 ..	—	—	—	—	,,	43	508	9	43	508	3.4
21 ..	5th	13	171	9	6th	30	655	In milk	43	826	3.9
48 ..	—	—	—	—	,,	40	1255	,,	40	1255	3.1
12 ..	7th	22	275	13	8th	17	414	,,	39	689	3.8
Average for 36 Cows and Heifers in the Herd throughout the year, or completing one Lactation Period									41	686	3.8

HERD C.

No. or Name of Cow	Lact. Period	Weeks in Milk	Yield of Milk	Weeks Dry	Lact. Period	Weeks in Milk	Yield of Milk	Weeks dry	Records for the Year: Weeks in Milk	Yield of Milk	Percentage of Fat
			galls.				galls.			galls.	
7 Dairymaid ..	—	—	—	—	1st	52	684	In milk	**52**	**684**	4.7
19 Brindle ..	—	—	—	13	,,	35	552	4	**35**	**552**	3.9
2 Punch	1st	39	337	9	2nd	4	120	In milk	**43**	**457**	3.4
13 Tiny ..	,,	8	55	9	,,	30	482	,,	**38**	**537**	3.8
21 Mealy ..	,,	30	450	9	,,	13	334	,,	**43**	**784**	3.8
25 Lofty ..	,,	8	91	5	,,	39	385	,,	**47**	**476**	3.2
35 Gentle ..	—	—	—	5	,,	39	538	8	**39**	**538**	3.4
5 Fly ..	2nd	26	287	9	3rd	17	318	In milk	**43**	**605**	3.6
8 Lily ..	,,	26	257	9	,,	17	296	,,	**43**	**553**	3.9
15 Flower ..	,,	13	100	8	,,	31	679	,,	**44**	**779**	3.7
18 Crumple ..	,,	13	158	13	,,	26	492	,,	**39**	**650**	3.3
22 Rose ..	,,	26	376	9	,,	17	415	,,	**43**	**791**	3.4
29 Spot ..	,,	22	200	4	,,	26	431	,,	**48**	**631**	3.5
4 Cherry ..	—	—	—	—	,,	43	742	9	**43**	**742**	4.1
37 Daisy ..	—	—	—	9	,,	39	651	4	**39**	**651**	3.4
38 Lucy ..	—	—	—	7	,,	43	749	2	**43**	**749**	3.5
6 Lark ..	3rd	8	63	9	4th	35	671	In milk	**43**	**734**	3.9
9 Happy ..	,,	13	165	13	,,	26	598	,,	**39**	**763**	3.7
10 Smut ..	,,	35	547	13	,,	4	113	,,	**39**	**660**	3.4
11 Primrose ..	,,	35	620	9	,,	8	247	,,	**43**	**867**	4.1
27 Fancy ..	,,	8	75	5	,,	39	772	,,	**47**	**847**	3.1
39 Carrie ..	—	—	—	9	,,	39	746	4	**39**	**746**	3.7
1 Lively ..	4th	13	128	9	5th	30	651	In milk	**43**	**779**	3.3
14 Tit ..	,,	4	25	13	,,	26	210	,,	**30**	**235**	3.6
16 Tulip ..	,,	17	158	13	,,	22	543	,,	**39**	**701**	3.4
30 Snowdrop ..	,,	22	380	13	,,	17	420	,,	**39**	**800**	3.2
31 Blackmore ..	,,	35	617	4	,,	13	332	,,	**48**	**949**	3.4
40 Lucky ..	—	—	—	—	,,	43	687	,,	**43**	**687**	3.4
36 Darkie ..	—	—	—	5	6th	39	536	8	**39**	**536**	2.8
20 Moss Rose ..	6th	35	447	9	7th	8	130	In milk	**43**	**577**	4.8
24 Uphorn ..	,,	30	475	14	,,	8	220	,,	**38**	**695**	3.4
34 Butterfly ..	,,	26	321	13	,,	13	270	,,	**39**	**591**	3.4
3 Kitty ..	7th	35	588	9	8th	4	106	,,	**39**	**694**	3.7
12 White Legs	8th	22	291	8	9th	22	419	,,	**44**	**710**	3.5
Average for 34 Cows and Heifers in the Herd throughout the year									**41**	**669**	**3.6**

HERD D.

No. or Name of Cow	Lact. Period	Weeks in Milk	Yield of Milk	Weeks Dry	Lact. Period.	Weeks in Milk	Yield of Milk	Weeks Dry	Records for the Year: Weeks in Milk	Records for the Year: Yield of Milk	Records for the Year: Percentage of Fat
			galls.				galls.				
25 Flower ..	—	—	—	—	1st	48	480	4	48	480	3.8
26 Brown ..	—	—	—	—	,,	47	607	5	47	607	3.6
28 Bunting	—	—	—	—	,,	30	241	In milk	—	—	3.9
Peggy ..	—	—	—	—	,,	22	221	,,	—	—	4.9
Darkie ..	—	—	—	—	,,	9	128	,,	—	—	3.3
23 Coronation ..	1st	17	127	9	2nd	26	384	,,	43	511	3.5
27 Rhoda ..	—	—	—	—	,,	42	546	,,	42	546	3.6
Myrtle ..	—	—	—	—	,,	13	170	,,	—	—	4.4
7 Crumple ..	—	—	—	—	,,	42	585	10	42	585	3.7
16 Blossom ..	2nd	8	80	18	3rd	26	536	In milk	34	616	3.1
15 Matilda ..	—	—	—	—	,,	52	1006	,,	52	1006	3.2
Nimble ..	—	—	—	—	,,	9	189	,,	—	—	3.4
12 Dutchman ..	—	—	—	—	4th	43	700	,,	43	700	3.2
13 Tin Ribs ..	—	—	—	—	,,	52	808	,,	52	808	3.6
18 Blue Bell ..	—	—	—	—	,,	39	704	13	39	704	3.4
21 Goat ..	—	—	—	5	,,	43	759	4	43	759	3.3
8 Skinny ..	4th	17	172	13	5th	22	494	In milk	39	666	4.1
9 Strawberry ..	,,	39	578	9	,,	4	115	,,	48	693	3.6
17 Smoker ..	,,	38	391	9	,,	5	117	,,	43	508	5.6
3 Parson ..	—	—	—	—	,,	35	764	,,	—	—	3.0
1 Barney ..	—	—	—	—	,,	48	776	4	48	776	3.3
9 Mealy ..	5th	30	445	5	6th	17	383	In milk	47	828	3.4
14 Fat Jack ..	,,	4	34	9	,,	39	787	,,	43	821	2.8
6 Flea ..	—	—	—	—	,,	52	642	,,	52	642	3.4
11 Betsy ..	6th	22	317	9	7th	21	473	,,	43	790	3.4
19 Jimmer ..	7th	13	134	13	8th	26	523	,,	39	657	3.4
2 Polly ..	,,	8	57	13	,,	30	429	,,	38	486	3.5
Average for 21 Cows and Heifers in the Herd throughout the year, or completing one Lactation Period									44	675	3.6

HERD E.

No. of Cow		Lact. Period	Weeks in Milk	Yield of Milk	Weeks Dry	Lact. Period	Weeks in Milk	Yield of Milk	Weeks Dry	Records for the Year: Weeks in Milk	Records for the Year: Yield of Milk	Records for the Year: Percentage of Fat
				galls				galls.			galls.	
34	..	1st	26	306	9	2nd	13	217	In milk	39	523	3.7
45	..	—	—	—	—	,,	26	448	,,	—	—	3.8
50	..	—	—	—	—	,,	20	240	,,	—	—	3.5
52	..	—	—	—	—	,,	19	360	,,	—	—	3.1
53	..	—	—	—	—	,,	19	417	,,	—	—	3.1
31	..	—	—	—	—	,,	43	601	9	43	601	3.2
40	..	—	—	—	18	,,	26	418	8	26	418	3.3
9	..	2nd	26	263	9	3rd	8	189	In milk	34	452	3.7
10	..	,,	17	254	17	,,	18	386	,,	35	640	2.9
32	..	,,	17	272	9	,,	26	445	,,	43	717	3.3
33	..	,,	21	308	9	,,	22	510	,,	43	818	3.3
55	..	—	—	—	—	,,	13	338	,,	—	—	3.2
56	..	—	—	—	—	,,	13	400	,,	—	—	3.3
14	..	—	—	—	—	,,	47	695	5	47	695	2.9
39	..	—	—	—	—	,,	30	563	13	30	563	3.0
1	..	3rd	13	121	22	4th	17	422	In milk	30	543	3.7
4	..	,,	22	202	26	,,	4	148	,,	26	350	3.1
5	..	,,	12	123	5	,,	35	784	,,	47	907	2.9
12	..	,,	26	404	13	,,	13	407	,,	39	811	3.5
20	..	,,	13	130	22	,,	17	375	,,	30	505	3.2
28	..	,,	13	133	17	,,	13	257	,,	26	390	3.8
30	..	,,	22	267	13	,,	17	439	,,	39	706	3.5
35	..	,,	26	428	13	,,	8	283	,,	34	711	3.7
47	..	—	—	—	—	,,	25	547	,,	—	—	3.2
6	..	4th	26	408	13	5th	13	364	In milk	39	772	3.1
8	..	,,	30	514	17	,,	5	133	,,	35	647	3.3
15	..	,,	13	187	22	,,	17	454	,,	30	641	3.3
23	..	,,	30	516	13	,	9	293	,,	39	809	3.2
27	..	,,	8	45	9	,,	17	225	,,	25	270	4.5
29	..	,,	8	74	9	,,	35	699	,,	43	773	3.4
48	..	—	—	—	—	,,	26	529	,,	—	—	3.4
49	..	—	—	—	—	,,	26	601	,,	—	—	3.8
51	..	—	—	—	—	,,	22	517	,,	—	—	3.3
41	..	—	—	—	14	,,	30	410	8	30	410	2.9
42	..	—	—	—	14	,,	34	602	4	34	602	2.8
Average for 25 Cows and Heifers in the Herd throughout the year, or completing one Lactation Period										35	611	3.3

HERD F.

No. of Cow	Lact. Period	Weeks in Milk	Yield of Milk	Weeks Dry	Lact. Period	Weeks in Milk	Yield of Milk	Weeks Dry	Records for the Year: Weeks in Milk	Records for the Year: Yield of Milk	Records for the Year: Percentage of Fat
			galls.				galls.				
7 ..	—	—	—	—	1st	30	306	In milk	—		3.2
14 ..	—	—	—	—	,,	18	181	,,	—	—	3.8
28 ..	1st	26	225	17	2nd	9	182	,,	35	40	3.7
43 ..	,,	22	247	22	,,	8	175	,,	30	422	3.5
50 ..	,,	13	176	18	,,	21	330	,,	34	506	3.1
48 ..	,,	26	263	9	,,	17	217	,,	43	480	3.1
44 ..	,,	31	258	17	,,	4	97	,,	35	355	3.3
16 ..	,,	13	119	17	,,	22	315	,,	35	434	3.0
21 ..	,,	22	355	4	,,	22	405	,,	44	760	3.0
2 ..	,,	8	91	17	,,	17	297	,,	25	388	3.4
35 ..	,,	18	193	9	,,	15	272	,,	33	465	3.2
60 ..	—	—	—	—	—	26	310	,,	—	—	3.4
9 ..	2nd	26	323	17	3rd	9	224	,,	35	547	3.5
27 ..	,,	8	88	17	,,	26	526	,,	34	614	2.8
32 ..	,,	22	288	13	,,	17	347	,,	39	635	3.2
31 ..	,,	8	76	22	,,	22	232	,,	30	308	3.7
59 ..	,,	35	572	13	,,	4	102	,,	39	674	3.1
22 ..	,,	22	334	9	,,	21	499	,,	43	833	3.2
46 ..	,,	13	181	22	,,	17	261	,,	30	416	3.5
57 ..	—	—	—	22	,,	22	345	8	22	345	3.8
8 ..	3rd	31	532	17	4th	4	111	In milk	35	643	3.4
5 ..	,,	22	313	13	,,	13	263	,,	35	576	3.2
3 ..	,,	22	285	13	,,	17	361	,,	39	646	3.2
55 ..	,,	22	363	13	,,	17	367	,,	39	730	3.1
23 ..	,,	13	167	18	,,	21	412	,,	34	579	4.1
13 ..	—	—	—	17	,,	35	826	,,	35	826	3.3
51 ..	—	—	—	—	,,	17	255	,,	—	—	3.4
10 ..	—	—	—	—	,,	35	661	17	35	661	3.5
17 ..	—	—	—	8	,,	35	593	9	35	593	3.5
11 ..	—	—	—	13	,,	26	739	13	26	739	3.2
58 ..	4th	13	216	30	5th	9	110	In milk	22	326	3.4
34 ..	,,	26	349	18	,,	8	242	,,	34	591	3.6
16 ..	,,	22	273	13	,,	17	327	,,	39	600	3.9
37 ..	,,	26	273	18	,,	8	183	,,	35	456	3.6
1 ..	—	—	—	—	,,	44	756	8	44	756	3.7
26 ..	—	—	—	—	,,	30	565	22	30	565	3.1
38 ..	—	—	—	—	6th	52	698	In milk	52	698	3.6
40 ..	—	—	—	—	,,	48	993	4	48	993	3.1
20 ..	6th	30	548	13	7th	9	263	In milk	39	811	3.2
30 ..	—	—	—	—	,,	35	518	8	35	514	3.7
33 ..	8th	26	328	9	9th	8	112	In milk	34	440	3.3
24 ..	—	—	—	—	?	13	92	,,	—	—	3.9
18 ..	—	—	—	—	?	18	401	,,	—	—	3.2
45 ..	—	—	—	—	?	8	108	,,	—	—	3.1
1a ..	—	—	—	—	?	8	136	,,	—	—	3.8
29 ..	—	—	—	—	?	8	120	,,	—	—	3.6
12 ..	—	—	—	13	?	26	403	13	26	403	3.2
52 ..	—	—	—	—	?	35	386	17	35	386	3.3
Average for 39 Cows and Heifers in the Herd throughout the year, or completing one Lactation Period									35	567	3.4

HERD G. (11 months only).

No. of Cow	Lact. Period	Weeks in Milk	Yield of Milk	Weeks Dry	Lact. Period	Weeks in Mil	Yield of Milk	Weeks Dry	Records for the Year: Weeks in Milk	Records for the Year: Yield of Milk	Records for the Year: Percentage of Fat
			galls.				galls.				
17 ..	—	—	—	—	1st	48	737	In milk	48	737	4·4
19 ..	—	—	—	—	,,	48	740	,,	48	740	3·4
35 ..	—	—	—	—	,,	48	922	,,	48	922	3·5
6 ..	—	—	—	—	,,	35	570	13	35	570	3·5
8 ..	—	—	—	—	,,	35	339	13	35	339	4·1
25 ..	—	—	—	—	,,	43	529	5	43	529	3·6
11 ..	—	—	—	—	,,	47	542	1	47	542	4·0
4 ..	1st	8	51	6	2nd	34	567	In milk	42	618	4·2
18 ..	,,	22	197	13	,,	13	268	,,	35	465	3·8
20 ..	,,	17	204	17	,,	13	438	,,	30	642	3·2
21 ..	,,	13	126	13	,,	13	284	,,	26	410	3·8
23 ..	,,	13	171	13	,,	13	306	,,	26	477	3·1
37 ..	—	—	—	7	,,	41	703	,,	41	703	3·7
38 ..	—	—	—	9	,,	39	576	,,	39	576	3·5
1 ..	2nd	35	513	4	3rd	9	161	,,	44	674	3·5
2 ..	,,	30	380	4	,,	13	412	,,	43	792	3·6
7 ..	,,	22	196	13	,,	13	407	,,	35	603	3·3
15 ..	,,	26	373	1	,,	21	435	,,	47	808	3·7
27 ..	,,	17	135	9	,,	17	396	,,	34	531	3·7
10 ..	—	—	—	—	,,	39	819	,,	39	819	3·1
24 ..	—	—	—	—	,,	30	629	,,	—	—	3·4
28 ..	—	—	—	—	,,	30	393	,,	—	—	3·7
13 ..	3rd	22	365	4	4th	22	489	,,	44	854	3·1
31 ..	,,	8	74	0	,,	40	920	,,	48	994	3·1
32 ..	,,	4	30	4	,,	39	819	,,	43	849	3·6
33 ..	,,	4	24	9	,,	35	627	,,	39	651	3·2
34 ..	,,	4	36	9	,,	35	861	,,	39	897	3·7
3 ..	—	—	—	—	,,	48	804	,,	48	804	3·7
16 ..	—	—	—	5	,,	39	722	4	39	722	2.8
29 ..	—	—	—	—	,,	39	798	9	39	798	3·1
30 ..	6th	4	13	9	7th	34	843	In Milk	37	856	3·1
39 ..	—	—	—	4	?	44	686	—	44	686	3·5
40 ..	—	—	—	—	?	22	414	—	—	—	3·6
Average for 30 Cows and Heifers in the Herd throughout the year, or completing one Lactation Period									40	687	3.4

HERD H.

No of Cow		Lact. Period	Weeks in Milk	Yield of Milk	Weeks Dry	Lact. Period	Weeks in Milk	Yield of Milk	Weeks Dry	Records for the Year: Weeks in Milk	Records for the Year: Yield of Milk	Records for the Year: Percentage of Fat
				galls.				galls.			galls.	
4	..	—	—	—	—	1st	48	564	4	48	564	3·4
14	..	—	—	—	—	,,	43	400	9	43	400	4·1
44	..	—	—	—	—	,,	30	371	In milk	—	—	3·4
51	..	—	—	—	—	,,	26	318	,,	—	—	4·0
58	..	—	—	—	—	,,	13	206	,,	—	—	3·9
60	..	—	—	—	—	,,	8	157	,,	—	—	4·3
18	..	1st	27	275	8	2nd	17	153	,,	44	428	3·7
41	..	—	—	—	—	,,	32	395	,,	—	—	3·6
52	..	—	—	—	—	,,	26	253	,,	—	—	4·2
53	..	—	—	—	—	,,	26	224	,,	—	—	3·9
39	..	—	—	—	7	,,	39	457	6	39	457	4·0
1	..	2nd	25	431	6	3rd	21	446	In milk	46	877	3·6
13	..	,,	25	269	6	,,	21	378	,,	6	647	3·7
27	..	—	—	—	—	,,	26	417	,,	—	—	3·3
28	..	—	—	—	—	,,	34	408	,,	—	—	3·5
49	..	—	—	—	—	,,	27	494	,,	—	—	3·5
50	..	—	—	—	—	,,	28	373	,,	—	—	3·4
59	..	—	—	—	—	,,	6	122	,,	—	—	4·2
32	..	—	—	—	—	,,	39	423	8	39	423	3·5
38	..	—	—	—	4	,,	39	684	4	39	684	4·4
3	..	3rd	25	319	9	4th	24	441	In milk	49	760	4·2
19	..	,,	13	126	3	,,	26	397	,,	39	523	3·9
7	..	—	—	—	13	,,	43	449	9	43	449	4·5
25	..	4th	5	30	—	5th	39	704	In milk	44	734	4·0
31	..	,,	38	440	8	,,	4	97	,,	42	537	3·1
35	..	,,	39	697	10	,,	4	60	,,	43	757	3·5
57	..	—	—	—	6	,,	10	230	,,	—	—	3·4
29	..	—	—	—	—	6th	38	460	,,	—	—	3·3
56	..	—	—	—	—	,,	10	197	,,	—	—	3·5
5	..	6th	8	69	—	7th	26	495	,,	34	564	3·5
33	..	—	—	—	18	?	42	723	6	42	723	3·6
6	..	?	36	377	4	?	9	199	In milk	45	576	3·6
37	..	—	—	—	9	?	43	780	,,	43	780	3·3
46	..	—	—	—	—	?	30	449	,,	—	—	3·4
47	..	—	—	—	—	?	26	247	,,	—	—	3·3
48	..	—	—	—	—	?	26	236	,,	—	—	3·8
55	..	—	—	—	—	?	17	206	,,	—	—	3·7
61	..	—	—	—	—	?	15	202	,,	—	—	3·9
Average for 18 Cows and Heifers in the Herd throughout the year, or completing one Lactation Period										43	604	3.7

HERD I.

No. of Cow	Lact. Period	Weeks in Milk	Yield of Milk	Weeks Dry	Lact. Period	Weeks in Milk	Yield of Milk	Weeks Dry	Records for the Year: Weeks in Milk	Records for the Year: Yield of Milk	Records for the Year: Percentage of Fat
			galls.				galls.			galls.	
15 ..	—	—	—	—	1st	30	327	In milk	—	—	3·7
18 ..	—	—	—	—	,,	22	186	,,	—	—	3·8
30*a* ..	—	—	—	—	,,	17	265	,,	—	—	3·6
33 ..	—	—	—	—	,,	26	268	,,	—	—	4·2
34 ..	—	—	—	—	,,	26	321	,,	—	—	3·3
35 ..	—	—	—	—	,,	17	208	,,	—	—	4·4
36 ..	—	—	—	—	,,	17	250	,,	—	—	4·2
37 ..	—	—	—	—	,,	17	285	,,	—	—	3·2
13*a* ..	—	—	—	—	,,	17	251	,,	—	—	3·4
38 ..	—	—	—	—	,,	13	265	,,	—	—	3·6
39 ..	—	—	—	—	,,	13	176	,,	—	—	4·2
21*a* ..	—	—	—	—	,,	8	210	,,	—	—	3·2
17 ..	1st	26	328	9	2nd	17	265	,,	43	593	3·5
21 ..	,,	24	285	6	,,	9	212	,,	33	497	3·7
29 ..	,,	26	441	4	,,	22	450	,,	48	891	3·6
26 ..	—	—	—	—	,,	25	327	,,	—	—	3·6
31 ..	—	—	—	—	,,	43	597	9	43	597	4·2
41 ..	—	—	—	—	,,	12	239	In milk	—	—	3·7
2*a* ..	—	—	—	—	,,	8	207	,,	—	—	4·3
4 ..	—	—	—	5	,,	43	576	4	43	576	3·4
9 ..	2nd	13	80	13	3rd	26	410	In milk	39	490	3·8
14 ..	,,	13	143	9	,,	30	517	,,	43	660	3·5
28 ..	,,	8	84	5	,,	35	645	,,	43	729	3·6
10 ..	—	—	—	—	,,	52	865	,,	52	865	3·7
6 ..	—	—	—	—	,,	39	638	13	39	638	3·7
1 ..	3rd	13	104	9	4th	30	551	In milk	43	655	4·0
3 ..	,,	27	357	21	,,	4	166	,,	31	523	3·4
40 ..	—	—	—	—	,,	12	166	,,	—	—	4·6
16*a* ..	—	—	—	—	,,	4	72	,,	—	—	3·3
42 ..	—	—	—	—	,,	4	93	,,	—	—	3·6
16 ..	4th	10	134	12	5th	30	344	,,	40	478	3·8
19 ..	,,	12	81	10	,,	30	325	,,	42	406	4·0
20 ..	,,	13	139	9	,,	30	529	,,	43	668	3·8
5 ..	5th	17	219	9	6th	26	398	,,	43	617	3·4
7 ..	,,	21	286	9	,,	22	486	,,	43	772	2·9
25 ..	—	—	—	—	,,	26	388	,,	—	—	3·1
27 ..	—	—	—	—	,,	48	859	4	48	859	3·8
32 ..	—	—	—	—	7th	43	671	9	43	671	3·9
12 ..	—	—	—	9	10th	39	456	4	39	456	4·2
22 ..	—	—	—	13	?	35	491	4	35	491	3·7
24 ..	—	—	—	13	?	35	488	4	35	488	3·2
Average for 22 Cows and Heifers in the Herd throughout the year, or completing one Lactation Period									41	619	3.7

HERD J.

No. of Cow	Lact. Period	Weeks in Milk	Yield of Milk	Weeks Dry	Lact. Period	Weeks in Milk	Yield of Milk	Weeks Dry	Records for the Year: Weeks in Milk	Records for the Year: Yield of Milk	Records for the Year: Percentage of Fat.
			galls.				galls			galls.	
43 ..	—	—	—	—	2nd	43	868	9	43	868	3·0
4a ..	—	—	—	9	,,	35	455	8	35	455	3·3
10 ..	—	—	—	—	,,	48	857	4	48	857	3·5
17 ..	2nd	30	369	9	3rd	13	253	In milk	43	622	3·3
45 ..	,,	30	410	5	,,	17	438	,,	47	848	3·5
47 ..	,,	26	394	5	,,	21	399	,,	47	793	3·5
53 ..	,,	27	472	4	,,	21	517	,,	48	989	3·5
7 ..	—	—	—	—	,,	52	914	,,	52	914	3·3
2 ..	—	—	—	—	,,	48	689	4	48	689	3·3
5 ..	—	—	—	—	,,	43	640	9	43	640	3·4
12 ..	—	—	—	—	,,	43	733	9	43	733	3·8
58 ..	—	—	—	—	,,	43	919	9	43	919	3·5
30a ..	—	—	—	5	,,	43	753	4	43	753	3·3
6 ..	3rd	9	113	17	4th	26	507	In milk	35	620	3·2
16 ..	,,	43	639	5	,,	4	109	,,	47	748	3·4
20 ..	,,	29	350	2	,,	21	335	,,	50	685	3·1
23 ..	,,	8	147	9	,,	30	514	,,	38	661	3·2
24 ..	,,	26	369	4	,,	17	106	,,	43	475	3·3
25 ..	,,	26	402	4	,,	13	215	,,	39	617	3·4
29 ..	,,	22	399	4	,,	26	734	,,	48	1133	3·3
30 ..	,,	4	88	13	,,	30	499	,,	34	587	3·1
44 ..	,,	26	413	4	,,	22	473	,,	48	886	3·2
51 ..	,,	26	450	5	,,	21	319	,,	47	769	3·4
55 ..	,,	9	160	17	,,	26	494	,,	35	654	3·1
33 ..	—	—	—	—	,,	48	759	4	48	759	3·2
5a ..	—	—	—	5	,,	39	833	8	39	833	3·4
14a ..	—	—	—	5	,,	39	569	8	39	569	3·1
21a ..	—	—	—	9	,,	35	661	8	35	661	3·4
23a ..	—	—	—	9	,,	39	728	4	39	728	3·2
50 ..	—	—	—	—	,,	52	932	In milk	52	932	3·4
36a ..	—	—	—	5	,,	39	730	8	39	730	3·6
22 ..	4th	43	667	5	5th	4	98	In milk	47	765	3·3
32 ..	,,	30	530	9	,,	13	161	,,	43	691	3·4
35 ..	,,	32	480	7	,,	13	321	,,	44	801	3·3
37 ..	,,	30	489	9	,,	13	303	,,	43	792	3·3
38 ..	,,	39	406	9	,,	4	91	,,	43	497	3·3
40 ..	,,	26	403	4	,,	16	357	,,	42	760	3·3
61 ..	,,	4	70	13	,,	13	229	,,	—	—	3·3
62 ..	,,	39	558	4	,,	4	118	,,	43	676	3·1
60a ..	—	—	—	9	,,	43	644	,,	43	644	3·6
1 ..	—	—	—	—	,,	52	790	,,	52	790	3·5
63 ..	—	—	—	5	,,	39	653	8	39	653	3·7
6a ..	—	—	—	5	,,	39	591	8	39	591	3·4
31a ..	—	—	—	9	,,	39	706	4	39	706	3·1
28a ..	—	—	—	9	,,	39	671	4	39	671	3·3
31 ..	5th	9	174	17	6th	17	148	In milk	26	322	3·5
26a ..	,,	26	276	4	,,	17	284	,,	43	560	3·1
11 ..	6th	26	420	8	7th	13	340	,,	39	761	2·8
7a ..	—	—	—	—	?	30	403	9	—	—	3·1
8a ..	—	—	—	—	?	39	655	In milk	—	—	3·3
Average for 47 Cows and Heifers in the Herd throughout the year, or completing one Lactation Period									42	708	3·3

HERD K.

No. of Cow	Lact. Period	Weeks in Milk	Yield of Milk	Weeks Dry	Lact. Period	Weeks in Milk	Yield of Milk	Weeks Dry	Records for the Year		
									Weeks in Milk	Yield of Milk	Percentage of Fat.
			galls.				galls.			galls.	
73*a* ..	—	—	—	—	1st	26	322	In milk	—	—	3.2
31*b* ..	—	—	—	—	,,	26	385	,,	—	—	3.3
86 ..	1st	8	96	18	2nd	26	518	,,	34	614	3.2
89 ..	,,	26	290	4	,,	22	289	,,	48	579	3.5
90 ..	,,	13	119	4	,,	35	494	,,	38	613	3.1
25 *aa* ..	,,	22	271	9	,,	21	444	,,	43	715	3.4
82 ..	—	—	—	—	,,	32	503	,,	—	—	3.7
94 ..	—	—	—	—	,,	23	427	,,	—	—	4.3
79 ..	—	—	—	—	,,	36	628	,,	—	—	4.0
85 ..	—	—	—	—	,,	11	350	,,	—	—	3.4
95 ..	—	—	—	—	,,	16	268	,,	—	—	3.1
96 ..	—	—	—	—	,,	13	293	,,	—	—	3.2
40*a* ..	2nd	9	75	13	3rd	30	490	,,	39	565	3.0
81 ..	,,	26	238	4	,,	22	331	,,	48	569	3.7
83 ..	,,	17	183	9	,,	26	442	,,	43	625	2.8
80 ..	,,	17	111	13	,,	22	323	,,	39	434	3.1
7 ..	,,	22	213	13	,,	17	344	,,	39	557	3.8
25*c* ..	—	—	—	—	,,	29	634	,,	—	—	3.1
39*a* ..	—	—	—	—	4th	35	382	17	35	382	3.7
31*aa* ..	3rd	22	201	9	,,	21	479	In milk	43	680	3.3
31*c* ..	,,	26	399	9	,,	17	403	,,	43	802	3.4
25*b* ..	—	—	—	—	,,	40	496	,,	40	496	3.1
31*b* ..	4th	30	691	18	5th	4	195	,,	34	886	3.2
52 ..	—	—	—	—	,,	46	821	,,	46	821	3.4
70 ..	5th	30	504	9	6th	4	133	,,	34	637	3.6
25*a* ..	,,	30	638	13	,,	4	112	,,	34	750	3.3
75 ..	6th	17	167	18	7th	17	284	,,	34	451	3.1
71 ..	,,	13	101	9	,,	30	438	,,	43	539	3.1
31*a* ..	,,	30	823	13	,,	4	189	,,	34	1012	2.8
64 ..	—	—	—	—	,,	43	823	9	43	823	2.9
73 ..	7th	8	68	13	8th	26	429	In milk	34	497	3.8
54 ..	—	—	—	—	,,	43	872	9	43	872	3.0
Average for 23 Cows and Heifers in the Herd throughout the year, or completing one Lactation Period									39	636	3.3

HERD L.

No or Name of Cow.	Lact. Period	Weeks in Milk	Yield of Milk	Weeks Dry	Lact. Period	Weeks in Milk	Yield of Milk	Weeks Dry	Records for the Year		
									Weeks in Milk	Yield of Milk	Percentage of Fat
			galls				galls.			galls.	
Flower ..	—	—	—	—	1st	30	441	9	**30**	**441**	3·6
37 Nanny ..	—	—	—	—	,,	30	348	8	**30**	**348**	3·4
38 Tiny ..	—	—	—	—	,,	30	223	8	**30**	**223**	3·5
12 Lily ..	1st	26	330	13	2nd	4	100	In milk	**30**	**430**	3·7
13 Lucky ..	,,	18	265	12	,,	22	382	,,	**40**	**647**	3·2
17 Nutmeg ..	,,	19	216	11	,,	22	328	,,	**41**	**544**	3·7
18 Orpington ..	,,	20	223	6	,,	26	389	,,	**46**	**612**	3·7
19 Pale Face ..	,,	19	214	11	,,	22	314	,,	**41**	**528**	3·9
21 Rose ..	,,	24	358	11	,,	17	355	,,	**41**	**713**	4·0
24 Strawberry ..	,,	26	329	9	,,	17	296	,,	**43**	**625**	3·7
36 Tulip ..	—	—	—	—	,,	39	708	,,	**39**	**708**	3·3
34 Daisy ..	—	—	—	—	,,	33	549	4	**33**	**549**	3·6
5 Dairymaid ..	2nd	30	431	9	3rd	13	311	In milk	**43**	**742**	3·6
9 Gentle ..	,,	8	95	13	,,	31	553	,,	**39**	**648**	3·2
25 Sunrise ..	,,	28	331	7	,,	17	298	,,	**45**	**629**	3·9
27 Thistle ..	,,	28	405	20	,,	4	128	,,	**32**	**533**	3·3
4 Dolly ..	3rd	7	68	4	4th	30	545	,,	**37**	**613**	3·2
8 Fan ..	—	—	—	—	,,	52	903	,,	**52**	**903**	3·2
11 Jackman ..	—	—	—	—	,,	52	1135	,,	**52**	**1135**	3·2
10 Happy ..	4th	6	53	7	5th	35	702	,,	**41**	**755**	3·3
14 Myrtle ..	5th	34	607	9	6th	4	105	,,	**38**	**712**	3·6
7 Doubtful ..	—	—	—	—	7th	35	668	13	**35**	**668**	3·5
Hoofer ..	—	—	—	—	8th	26	322	In milk	—	—	4·2
Yellow Hammer	—	—	—	—	,,	30	504	9	**30**	**504**	3·7
6 Dahlia ..	?	13	152	13	?	26	536	In milk	**39**	**688**	3·6
16 Nell ..	?	30	639	17	?	5	152	,,	**35**	**791**	3·8
20 Polly ..	?	4	16	9	?	39	746	,,	**43**	**762**	3·2
26 Salsdon ..	?	6	62	6	?	35	657	,,	**41**	**719**	3·4
30 Brindle ..	—	—	—	—	?	35	548	9	—	—	3·8
39 Damsel ..	—	—	—	—	?	26	353	9	—	—	3·4
Average for 27 Cows and Heifers in the Herd throughout the year, or completing one Lactation Period									**39**	**636**	**3.6**

HERD M.

No. of Cow	Lact. Period	Weeks in Milk	Yield of Milk	Weeks Dry	Lact. Period	Weeks in Milk	Yield of Milk	Weeks Dry	Records for the Year: Weeks in Milk	Records for the Year: Yield of Milk	Percentage of Fat
			galls.				galls.			galls.	
81 ..	—	—	—	—	1st	17	228	In milk	—	—	4.6
82 ..	—	—	—	—	,,	17	309	,,	—	—	4.3
86 ..	—	—	—	—	,,	17	326	,,	—	—	3.7
90 ..	—	—	—	—	,,	13	128	,,	—	—	3.2
91 ..	—	—	—	—	,,	8	73	,,	—	—	3.9
34 ..	—	—	—	—	,,	39	458	13	—	—	4.0
3 ..	1st	24	385	15	2nd	13	362	In milk	37	747	3.5
49 ..	,,	22	184	13	,,	17	233	,,	39	417	4.4
50 ..	,,	26	253	9	,,	17	340	,,	43	593	3.9
87 ..	—	—	—	—	,,	26	478	,,	—	—	4.5
98 ..	—	—	—	—	,,	4	115	,,	—	—	4.6
99 ..	—	—	—	—	,,	4	116	,,	—	—	3.9
102 ..	—	—	—	—	,,	4	129	,,	—	—	3.2
2 ..	—	—	—	—	,,	31	422	21	31	422	4.4
27 ..	—	—	—	—	,,	34	571	18	34	571	3.6
60 ..	—	—	—	14	,,	30	495	8	30	495	4.1
1 ..	2nd	26	468	8	3rd	18	338	In milk	44	806	3.8
20 ..	,,	22	314	13	,,	17	467	,,	39	781	2.9
29 ..	,,	4	67	22	,,	17	253	,,	21	320	3.8
30 ..	,,	22	356	17	,,	13	315	,,	35	671	4.0
53 ..	,,	21	201	9	,,	22	418	,,	43	619	3.8
72 ..	—	—	—	9	,,	43	673	,,	43	673	3.8
78 ..	—	—	—	15	,,	37	498	,,	37	498	3.6
88 ..	—	—	—	—	,,	22	388	,,	—	—	3.1
89 ..	—	—	—	—	,,	22	460	,,	—	—	3.7
92 ..	—	—	—	—	,,	27	297	,,	—	—	3.4
95 ..	—	—	—	—	,,	7	166	,,	—	—	4.0
97 ..	—	—	—	—	,,	6	168	,,	—	—	2.9
100 ..	—	—	—	—	,,	4	127	,,	—	—	3.5
4 ..	3rd	9	137	17	4th	26	439	,,	35	576	3.1
15 ..	,,	8	100	5	,,	26	280	,,	34	380	3.7
18 ..	,,	22	422	8	,,	4	111	,,	26	533	3.7
21 ..	,,	26	626	13	,,	13	398	,,	39	1024	3.4
23 ..	,,	9	106	26	,,	9	89	,,	18	195	3.6
65 ..	—	—	—	9	,,	43	1056	,,	43	1056	3.2
75 ..	—	—	—	—	,,	34	595	,,	—	—	3.7
79 ..	—	—	—	—	,,	28	706	,,	—	—	3.3
80 ..	—	—	—	—	,,	28	555	,,	—	—	3.2
85 ..	—	—	—	—	,,	13	146	,,	—	—	3.4
96 ..	—	—	—	—	,,	4	96	,,	—	—	3.3
101 ..	—	—	—	—	,,	4	127	,,	—	—	4.3
54 ..	—	—	—	4	,,	39	867	9	39	867	3.4
55 ..	—	—	—	9	,,	39	823	4	39	823	3.5
57 ..	—	—	—	5	,,	39	960	8	39	960	3.8
69 ..	—	—	—	9	,,	26	369	17	26	369	3.5
9 ..	4th	8	150	22	5th	22	381	In milk	30	531	3.6
11 ..	,,	17	243	9	,,	26	635	,,	43	878	3.8
25 ..	,,	4	52	9	,,	34	584	,,	38	636	3.7
31 ..	,,	26	454	5	,,	21	608	,,	47	1062	3.8
32 ..	,,	26	426	0	,,	18	337	,,	44	763	3.5

HERD M—continued.

No. of Cow		Lact. Period	Weeks in Milk	Yield of Milk.	Weeks Dry	Lact. Period	Weeks in Milk	Yield of Milk	Weeks Dry	Records for the Year: Weeks in Milk	Records for the Year: Yield of Milk	Records for the Year: Percentage of Fat
				galls.				galls.			galls.	
36	..	4th	26	444	13	5th	13	342	In milk	**39**	**786**	3.6
37	..	,,	22	472	21	,,	9	251	,,	**31**	**724**	3.6
44	..	,,	4	36	9	,,	35	581	,,	**39**	**617**	3.4
56	..	—	—	—	5	,,	43	1007	4	**43**	**1007**	3.3
38	..	5th	26	598	13	6th	13	360	In milk	**39**	**958**	3.4
51	..	,,	26	291	8	,,	4	54	,,	**30**	**345**	3.8
64	..	—	—	—	13	,,	39	829	,,	**39**	**829**	2.6
71	..	—	—	—	9	,,	43	847	,,	**43**	**847**	3.0
5	..	6th	26	443	4	7th	18	308	,,	**44**	**751**	3.2
16	..	?	9	143	17	?	4	116	,,	—	—	4.2
Average for 37 Cows and Heifers in the Herd throughout the year, or completing one Lactation Period										**37**	**679**	**3.7**

HERD N.

No. or Name of Cow	Lact. Period	Weeks in Milk	Yield of Milk	Weeks Dry	Lact. Period	Weeks in Milk	Yield of Milk	Weeks Dry	Records for the Year: Weeks in Milk	Records for the Year: Yield of Milk	Records for the Year: Percentage of Fat
			galls.				galls.				
6 Magpie ..	—	—	—	—	1st	43	442	9	43	442	3.6
32 Nancy 2nd ..	—	—	—	—	,,	48	768	4	48	768	3.4
33 Lottie ..	—	—	—	—	,,	35	452	13	35	452	3.1
45 Loppy ..	—	—	—	—	,,	48	698	4	48	698	3.5
31 Bonny Face ..	1st	39	742	9	2nd	4	111	In milk	43	853	3.0
48 Lady ..	,,	17	193	9	,,	26	569	,,	43	762	3.7
58 Cowslip ..	,,	39	456	5	,,	8	211	,,	47	667	3.6
59 Onslip ..	,,	22	291	4	,,	26	387	,,	48	678	3.3
60 Fancy ..	,,	26	244	22	,,	4	119	,,	30	363	3.7
61 Damsel ..	,,	39	408	9	,,	4	88	,,	43	496	3.6
63 Lovely ..	,,	13	142	5	,,	30	276	,,	43	418	3.6
65 Robin ..	,,	22	240	8	,,	22	341	,,	44	581	3.8
66 Sally ..	,,	26	363	9	,,	17	409	,,	43	772	3.2
67 Wallflower ..	,,	26	219	13	,,	13	262	,,	39	481	3.7
69 Foxglove ..	—	—	—	5	,,	47	982	,,	47	982	3.1
27 Snowflake ..	—	—	—	14	,,	30	210	8	30	210	3.1
70 Pattie ..	—	—	—	8	,,	35	405	9	35	405	3.3
25 Queen ..	2nd	22	325	13	3rd	17	425	In milk	39	750	3.4
39 Whitefoot ..	,,	4	25	17	,,	26	409	,,	30	434	3.0
40 Pincher ..	,,	4	33	9	,,	39	697	,,	43	730	3.6
44 Winnie ..	,,	13	111	17	,,	17	325	,,	30	436	3.0
52 Broad ..	,,	14	180	6	,,	22	333	,,	36	513	3.5
62 Buster ..	,,	4	26	18	,,	30	543	,,	34	569	3.5
64 Twister ..	,,	13	95	17	,,	22	434	,,	35	529	3.3
71 Cauliflower ..	—	—	—	13	,,	35	631	4	35	631	3.1
2 Croydon ..	3rd	17	217	5	4th	30	469	In milk	47	686	3.3
3 Snowdrop ..	,,	26	557	17	,,	9	237	,,	35	794	3.1
4 Trilby ..	,,	26	555	13	,,	13	342	,,	39	897	3.3
10 Lucy ..	,,	34	507	14	,,	4	100	,,	38	607	3.5
26 Sandy ..	,,	22	466	9	,,	21	582	,,	43	1048	3.3
38 Cherry ..	,,	30	588	9	,,	13	395	,,	43	983	3.9
46 Roady ..	,,	13	137	9	,,	30	673	,,	43	810	3.8
50 Lavender ..	,,	26	277	22	,,	4	125	,,	30	402	3.2
54 Strawberry ..	,,	8	54	13	,,	31	608	,,	39	662	3.3
55 Lofty ..	,,	26	541	4	,,	22	602	,,	48	1143	3.4
56 Peggy ..	,,	39	701	5	,,	8	273	,,	47	974	4.0
22 Sophy ..	—	—	—	9	,,	43	907	,,	43	907	4.5
28 Cockhorn ..	—	—	—	—	,,	35	433	17	35	433	4.0
12 Beauty ..	4th	26	306	9	5th	17	341	In milk	43	647	3.5
13 Spot ..	,,	4	30	9	,,	39	898	,,	43	928	3.5
16 Chub ..	,,	30	320	9	,,	8	94	,,	38	414	4.0
49 Butterfly ..	,,	13	151	13	,,	26	430	,,	39	583	3.6
68 Nellie ..	—	—	—	5	,,	47	975	,,	47	975	3.3
73 Shamrock ..	—	—	—	21	,,	31	594	,,	31	594	3.2
18 Milkmaid ..	—	—	—	—	,,	36	571	16	36	571	3.4
72 Stockby ..	—	—	—	5	,,	30	420	17	30	420	3.7
75 Hearty ..	—	—	—	9	,,	26	359	17	26	359	3.3
76 Leicester ..	—	—	—	9	,,	39	620	4	39	620	3.0
11 Lassie ..	5th	13	224	9	6th	30	876	In milk	43	1100	3.3
4 Polly ..	,,	4	22	9	,,	39	837	,,	43	859	3.4

HERD N—continued.

No. or Name of Cow	Lact. Period	Weeks in Milk	Yield of Milk	Weeks Dry	Lact. Period	Weeks in Milk	Yield of Milk	Weeks Dry	Records for the Year: Weeks in Milk	Yield of Milk	Percentage of Fat
			galls.				galls.			galls.	
15 Champion ..	5th	26	315	4	6th	22	324	In milk	48	639	3·4
20 Molly ..	,,	35	943	4	,,	13	452	,,	48	1395	3·0
21 Lizzie ..	,,	26	442	8	,,	17	413	,,	43	855	3·5
36 Betty ..	—	—	—	—	,,	43	871	,,	43	871	3·0
23 Laurie ..	6th	39	854	9	7th	4	128	,,	43	982	3·2
8 Sweet-Heart	,,	13	90	9	,,	30	629	,,	43	719	3·1
5 Rose ..	—	—	—	—	,,	52	701	,,	52	701	2·9
47 Navvy ..	—	—	—	5	?	39	761	8	39	761	3·1
74 Nanny 1st ..	—	—	—	13	?	26	534	13	26	534	3·0
Average for 59 Cows and Heifers in the Herd throughout the year, or completing one Lactation Period									40	686	3.4

HERD O.

No. of Cow	Lact. Period	Weeks in Milk	Yield of Milk	Weeks Dry	Lact. Period	Weeks in Milk	Yield of Milk	Weeks Dry	Records for the Year. Weeks in Milk	Yield of Milk	Percentage of Fat.
			galls.				galls.			galls.	
26 ..	—	—	—	—	1st	26	630	In milk	—	—	3·7
44 ..	—	—	—	—	,,	17	278	,,	—	—	3·0
25 ..	—	—	—	4	,,	35	445	13	35	445	3·4
4 ..	1st	26	311	22	2nd	4	101	In milk	30	412	3·5
43a ..	—	—	—	—	,,	13	200	,,	—	—	4·1
27a ..	—	—	—	—	,,	8	138	,,	—	—	3·0
34 ..	2nd	26	436	22	3rd	4	124	,,	30	560	3·7
23 ..	,,	26	531	9	,,	17	300	,,	43	831	3·2
27 ..	,,	26	198	13	,,	13	242	,,	39	440	3·0
22a ..	—	—	—	—	,,	13	265	,,	—	—	3·6
23a ..	—	—	—	—	,,	24	430	,,	—	—	3·2
40 ..	—	—	—	—	,,	52	857	,,	52	857	3·3
46 ..	—	—	—	4	,,	39	698	9	39	698	4·7
33 ..	—	—	—	—	,,	44	654	8	44	654	3·5
3 ..	3rd	39	436	5	4th	8	260	In milk	47	696	3·9
6 ..	,,	32	392	7	,,	13	344	,,	45	736	3·4
29 ..	,,	35	614	4	,,	13	313	,,	48	927	3·7
11 ..	—	—	—	13	,,	35	459	4	35	459	3·4
21 ..	—	—	—	13	,,	30	507	9	30	507	3·1
31 ..	4th	13	134	13	5th	26	513	In milk	39	647	3·7
48 ..	,,	22	178	4	,,	26	403	,,	48	581	4·6
49 ..	,,	4	44	9	,,	39	600	,,	43	644	3·4
50 ..	,,	30	454	9	,,	13	292	,,	43	746	3·8
9 ..	—	—	—	—	,,	44	830	8	44	830	3·3
5 ..	5th	16	214	10	6th	26	561	In milk	42	775	3·5
24 ..	6th	13	121	4	7th	35	695	,,	48	816	3·2
42 ..	,,	4	28	13	,,	30	547	,,	34	575	3·1
45 ..	,,	17	204	13	,,	22	363	,,	39	567	3·4
32 ..	7th	26	393	13	8th	13	351	,,	39	744	3·3
28 ..	?	26	321	4	?	22	372	,,	48	693	3·1
44 ..	?	30	389	4	?	18	290	,,	48	679	3·0
30 ..	?	—	—	4	?	35	438	13	35	438	4·0
44a ..	—	—	—	—	?	17	680	In milk	—	—	3·0
Average for 26 Cows and Heifers in the Herd throughout the year, or completing one Lactation Period									41	652	3.5

HERD P.

No. of Cow	Lact. Period	Weeks in Milk	Yield of Milk	Weeks Dry	Lact. Period	Weeks in Milk	Yield of Milk	Weeks Dry	Records for the Year		
									Weeks in Milk	Yield of Milk	Percentage of Fat
			galls.				galls.			galls.	
78 ..	—	—	—	—	1st	22	321	,,	—	—	3·9
79 ..	—	—	—	—	,,	22	288	,,	—	—	3·7
80 ..	—	—	—	—	,,	22	162	,,	—	—	3·7
81 ..	—	—	—	—	,,	22	354	,,	—	—	3·9
82 ..	—	—	—	—	,,	22	364	,,	—	—	3·6
83 ..	—	—	—	—	,,	22	293	,,	—	—	3·1
84 ..	—	—	—	—	,,	22	337	,,	—	—	3·9
85 ..	—	—	—	—	,,	22	252	,,	—	—	3·5
87 ..	—	—	—	—	,,	22	347	,,	—	—	3·6
86 ..	—	—	—	—	,,	22	258	,,	—	—	4·4
88 ..	—	—	—	—	,,	18	239	,,	—	—	3·6
89 ..	—	—	—	—	,,	18	185	,,	—	—	4·3
90 ..	—	—	—	—	,,	18	294	,,	—	—	3·8
91 ..	—	—	—	—	,,	13	169	,,	—	—	3·5
92 ..	—	—	—	—	,,	13	208	,,	—	—	3·3
75 ..	—	—	—	—	,,	48	503	4	48	503	4·4
74 ..	1st	35	465	8	2nd	9	148	In milk	44	613	4·0
72 ..	,,	26	350	9	,,	17	295	,,	43	645	3·1
70 ..	,,	26	268	4	,,	22	319	,,	48	587	3·4
73 ..	,,	26	324	13	,,	13	231	,,	39	555	3·5
64 ..	—	—	—	—	,,	48	270	4	48	270	5·6
58 ..	—	—	—	—	,,	48	607	4	48	607	3·6
65 ..	2nd	31	463	8	3rd	13	281	In milk	44	744	3·8
26 ..	,,	26	241	4	,,	22	300	,,	48	541	5·1
67 ..	,,	26	378	4	,,	22	294	,,	48	672	3·4
62 ..	,,	30	462	9	,,	13	308	,,	43	770	3·6
68 ..	,,	30	500	9	,,	13	299	,,	43	799	3·9
59 ..	,,	35	351	13	,,	4	70	,,	39	421	3·4
25 ..	—	—	—	—	,,	48	274	4	48	274	5·4
4 ..	—	—	—	—	,,	39	430	4	39	430	4·0
30 ..	—	—	—	13	4th	39	660	In milk	39	660	3·7
7 ..	—	—	—	4	,,	48	826	,,	48	826	3·1
11 ..	—	—	—	—	,,	43	826	9	43	826	3·5
6 ..	—	—	—	4	,,	43	682	4	43	682	3·4
9 ..	4th	26	512	13	5th	13	299	In milk	39	811	4·2
53 ..	,,	31	440	13	,,	8	220	,,	39	660	3·8
13 ..	,,	31	466	13	,,	8	175	,,	39	641	3·4
24 ..	,,	26	558	18	,,	8	180	,,	34	738	3·5
10 ..	—	—	—	—	,,	30	617	13	30	617	2·8
20 ..	5th	26	378	9	6th	17	300	In milk	43	678	3·8
14 ..	,,	4	29	13	,,	35	659	,,	39	688	3·3
12 ..	,,	26	403	13	,,	13	339	,,	39	742	3·6
39 ..	,,	26	297	9	,,	17	484	,,	43	781	3·5
40 ..	—	—	—	9	7th	43	869	,,	43	869	3·4
47 ..	7th	26	451	9	8th	17	440	,,	43	891	3·3
50 ..	10th	26	327	4	11th	22	333	,,	48	660	3·4
52 ..	,,	31	664	13	,,	8	238	,,	39	902	4·3
42 ..	—	—	—	13	,,	39	577	,,	39	577	3·7
23 ..	—	—	—	—	?	52	702	,,	52	702	3·2
38 ..	?	35	620	9	?	8	201	,,	43	821	4·1
33 .	—	—	—	—	?	39	501	13	39	501	3·5
Average for 36 Cows and Heifers in the Herd throughout the year, or completing one Lactation Period									43	658	3.7

HERD Q.

No. of Cow	Lact. Period	Weeks in Milk	Yield of Milk	Weeks Dry	Lact. Period	Weeks in Milk	Yield of Milk	Weeks Dry	Records for the Year: Weeks in Milk	Records for the Year: Yield of Milk	Records for the Year: Percentage of Fat
			galls.				galls.			galls.	
33 ..	—	—	—	—	1st	52	833	In milk	52	833	3·2
32 ..	—	—	—	—	,,	43	322	9	43	322	3·5
76 ..	—	—	—	—	,,	17	288	In milk	—	—	3·1
77 ..	—	—	—	—	,,	17	292	,,	—	—	3·3
78 ..	—	—	—	—	,,	17	234	,,	—	—	3·3
82 ..	—	—	—	—	,,	13	242	,,	—	—	4·4
84 ..	—	—	—	—	,,	8	222	,,	—	—	3·2
83 ..	—	—	—	—	,,	8	157	,,	—	—	3·3
29 ..	1st	35	331	9	2nd	8	151	,,	43	482	4·3
30 ..	,,	30	89	18	,,	4	120	,,	34	209	5·1
31 ..	,,	34	332	5	,,	13	299	,,	47	631	4·1
36 ..	,,	22	214	17	,,	13	457	,,	35	671	3·5
37 ..	,,	8	58	18	,,	26	623	,,	34	681	3·4
74 ..	—	—	—	—	,,	28	400	,,	—	—	3·5
8 ..	—	—	—	—	,,	52	1072	,,	52	1072	3·6
39 ..	—	—	—	—	,,	47	815	5	47	815	3·6
62 ..	—	—	—	?	,,	39	632	9	39	632	3·3
63 ..	—	—	—	?	,,	31	432	17	31	432	3·2
3 ..	2nd	30	332	5	3rd	17	328	In milk	47	660	3·2
11 ..	,,	22	254	22	,,	8	246	,,	30	500	3·5
20 ..	,,	17	206	18	,,	17	318	,,	34	524	3·1
23 ..	,,	30	418	9	,,	13	386	,,	43	804	3·7
71 ..	—	—	—	—	,,	42	560	,,	—	—	5·0
46 ..	—	—	—	—	,,	39	624	13	39	624	3·7
67 ..	—	—	—	—	,,	39	623	9	39	623	4·4
9 ..	3rd	8	69	9	4th	35	785	In milk	43	854	3·3
10 ..	,,	30	433	13	,,	9	276	,,	39	709	3·1
18 ..	,,	26	560	4	,,	22	327	,,	48	887	3·9
25 ..	,,	13	167	9	,,	30	576	,,	43	743	3·1
40 ..	,,	4	47	4	,,	35	531	,,	39	578	3·2
50 ..	,,	39	721	9	,,	4	115	,,	43	836	3·3
53 ..	,,	26	346	18	,,	8	280	,,	34	626	3·1
80 ..	—	—	—	—	,,	6	183	,,	—	—	3·7
85 ..	—	—	—	—	,,	5	243	,,	—	—	3·7
41 ..	—	—	—	—	,,	35	418	17	35	418	3·2
55 ..	—	—	—	—	,,	52	880	In milk	52	880	3·4
13 ..	4th	39	630	9	5th	4	92	,,	43	722	3·8
14 ..	,,	8	95	14	,,	30	650	,,	38	745	3·6
49 ..	,,	4	29	9	,,	39	858	,,	43	887	3·5
56 ..	,,	22	283	4	,,	26	586	,,	48	869	3·4
69 ..	—	—	—	—	,,	42	857	,,	42	857	3·5
79 ..	—	—	—	—	,,	9	228	,,	—	—	—
45 ..	—	—	—	—	,,	47	849	5	47	849	3·4
58 ..	—	—	—	—	,,	39	645	13	39	645	3·6
64 ..	—	—	—	4	,,	35	649	13	35	649	3·4
68 ..	—	—	—	9	,,	39	745	4	39	745	3·7
7 ..	5th	26	403	9	6th	17	333	In milk	43	736	3·7
15 ..	,,	35	675	13	,,	4	152	,,	39	827	4·0
28 ..	,,	17	220	9	,,	26	549	,,	43	769	3·1
59 ..	,,	4	32	9	,,	39	882	,,	43	914	3·5

HERD Q—continued.

No. of Cow.	Lact. Period	Weeks in Milk	Yield of Milk	Weeks Dry	Lact. Period	Weeks in Milk	Yield of Milk	Weeks Dry	Records for the Year. Weeks in Milk	Yield of Milk	Percentage of Fat
			galls.				galls.			galls.	
1 ..	—	—	—	—	6th	52	1101	In milk	52	1101	3·7
19 ..	—	—	—	—	,,	39	671	13	39	671	3·6
26 ..	—	—	—	—	,,	39	678	13	39	678	3·4
6 ..	6th	4	66	18	7th	30	767	In milk	34	833	3·1
12 ..	,,	22	260	17	,,	13	418	,,	35	678	3·4
16 ..	,,	30	723	9	,,	13	441	,,	43	1164	3·0
24 ..	,,	4	58	22	,,	26	679	,,	30	737	3·0
42 ..	,,	22	285	4	,,	26	436	,,	48	721	3·4
44 ..	,,	4	41	18	,,	30	757	,,	34	798	3·5
2 ..	—	—	—	—	,,	43	922	9	43	922	3·3
22 ..	7th	8	135	18	8th	26	503	In milk	34	638	3·7
70 ..	—	—	—	7	,,	43	898	2	43	898	3·3
72 ..	—	—	—	9	,,	39	738	4	39	738	3·1
73 ..	—	—	—	—	?	38	715	In milk	—	—	—
75 ..	—	—	—	—	?	36	659	,,	—	—	—
86 ..	—	—	—	—	?	2	44	,,	—	—	—
Average for 52 Cows and Heifers in the Herd throughout the year, or completing one Lactation Period									40	727	3.5

HERD R.

No. or Name of Cow.	Lact. Period	Weeks in Milk	Yield of Milk	Weeks Dry	Lact. Period	Weeks in Milk	Yield of Milk	Weeks Dry	Records for the Year: Weeks in Milk	Records for the Year: Yield of Milk	Records for the Year: Percentage of Fat
			galls.				galls.			galls.	
7 Lucy ..	—	—	—	—	1st	52	667	In milk	52	667	3·8
38 Pat ..	—	—	—	—	,,	52	809	,,	52	809	3·4
60 Kitty ..	—	—	—	9	,,	39	446	4	39	446	3·3
22 Aster ..	1st	26	391	9	2nd	17	337	In milk	43	728	3·2
26 Lucky ..	,,	26	355	13	,,	13	295	,,	39	650	3·1
35 Reading ..	,,	22	346	13	,,	17	370	,,	39	716	3·4
40 Darling ..	,,	22	234	4	,,	26	420	,,	48	654	4·1
46 Tot ..	,,	26	388	9	,,	17	363	,,	43	751	3·8
3 Jenny	,,	—	—	1	,,	51	778	,,	51	778	4·2
61 May ..	—	—	—	—	,,	32	417	,,	—	—	4·0
65 Rufus ..	—	—	—	—	,,	37	546	,,	37	546	3·1
41 Flower ..	2nd	13	147	13	3rd	26	544	,,	39	691	3·5
55 Star ..	—	—	—	7	,,	45	680	,,	45	680	3·5
59 Lily	—	—	—	12	,,	40	686	,,	40	686	3·4
67 Rose ..	—	—	—	22	,,	30	421	,,	—	—	3·5
71 Strawberry	—	—	—	—	,,	20	370	,,	—	—	3·7
Winnie ..	—	—	—	—	,,	4	112	,,	—	—	3·5
Roaney ..	—	—	—	—	,,	4	135	,,	—	—	3·3
15 Whiteface ..	3rd	26	412	17	4th	9	213	,,	35	625	3·5
28 Tulip ..	,,	13	105	8	,,	31	532	,,	44	637	3·4
31 Topsy ..	,,	22	270	9	,,	21	450	,,	43	720	3·3
33 Betty ..	,,	4	44	4	,,	44	771	,,	48	815	3·1
42 Bell ..	,,	13	98	22	,,	17	341	,,	30	439	3·4
51 Ruby ..	,,	9	104	17	,,	26	404	,,	35	508	4·0
Lady ..	—	—	—	—	,,	4	81	,,	—	—	5·1
Amy ..	—	—	—	—	,,	6	184	,,	—	—	4·0
13 Plum ..	—	—	—	—	,,	35	375	17	35	375	3·4
54 Spider ..	—	—	—	—	,,	31	510	17	—	—	—
30 Pansy ..	4th	8	71	9	5th	35	730	In milk	43	801	3·2
32 Smart ..	,,	13	145	20	,,	19	370	,,	32	515	3·2
34 Blossom ..	,,	22	332	13	,,	17	336	,,	39	668	3·7
50 Tiny ..	,,	18	242	8	,,	26	645	,,	44	887	3·3
66 Gentle ..	,,	—	—	—	,,	26	604	,,	—	—	3·7
14 Cowslip ..	5th	17	298	8	6th	27	617	,,	44	915	3·2
18 Longhorn ..	,,	13	185	26	,,	13	153	,,	26	338	3·6
27 Phlox ..	,,	22	384	13	,,	17	361	,,	39	745	3·2
9 Primrose ..	—	—	—	—	,,	43	498	9	43	498	3·3
39 Ivy ..	6th	22	297	13	7th	17	226	In milk	39	523	3·3
Cream ..	—	—	—	—	,,	21	347	,,	—	—	3·7
1 Wall Eye	7th	26	535	13	8th	13	359	,,	39	894	3·4
6 Brindle ..	,,	17	270	13	,,	22	502	,,	39	772	4·1
19 Comet ..	,,	4	25	13	,,	30	336	,,	34	361	3·5
21 Murphy ..	,,	26	307	13	,,	13	289	,,	39	596	3·3
37 Floss ..	,,	17	153	4	,,	31	481	,,	48	634	3·6
56 Nell	—	—	—	—	,,	48	740	,,	48	740	3·6
Faith ..	—	—	—	—	,,	10	219	,,	—	—	3·9
64 Rock ..	—	—	—	—	,,	35	641	,,	—	—	3·9
10 Dove ..	—	—	—	—	,,	39	577	13	39	577	3·4
36 Pincher ..	—	—	—	—	,,	39	427	13	39	427	4·5

HERD R—continued.

No. or Name of Cow	Lact. Period	Weeks in Milk	Yield of Milk	Weeks Dry	Lact. Period	Weeks in Milk	Yield of Milk	Weeks Dry	Records of the Year		
									Weeks in Milk	Yield of Milk	Percentage of Fat
			galls.				galls.			galls.	
2 Susan ..	8th	22	227	9	9th	27	545	In milk	49	772	3·5
47 Myrtle ..	,,	4	44	13	,,	35	495	,,	39	539	3·6
11 Baldy	—	—	—	—	,,	48	645	4	48	645	3·2
63 Fan ..	—	—	—	—	10th.	35	557	In milk	—	—	3·4
68 Pink ..	—	—	—	—	,,	33	558	,,	—	—	3·6
Buttercup 2nd	—	—	—	—	,,	26	601	,,	—	—	3·0
70 Crumple ..	—	—	—	—	?	25	503	,,	—	—	3·3
Beauty 2nd ..	—	—	—	—	?	22	304	,,	—	—	3·2
Bonnie ..	—	—	—	—	?	4	143	,,	—	—	4·4
Bletchely ..	—	—	—	—	?	4	127	,,	—	—	4·8
Average for 40 Cows and Heifers in the Herd throughout the year, or completing one Lactation Period									41	638	3.5

HERD S.

No. or Name of Cow	Lact. Period	Weeks in Milk	Yield of Milk	Weeks Dry	Lact. Period	Weeks in Milk	Yield of Milk	Weeks Dry	Records of the Year: Weeks in Milk	Records of the Year: Yield of Milk	Records of the Year: Percentage of Fat
			gals.				galls.			galls.	
29 Gentle ..	—	—	—	—	1st	52	734	In milk	52	734	3·5
8 Lophorn ..	—	—	—	—	,,	38	461	14	38	461	3·0
18 Patsy ..	1st	5	67	15	2nd	32	418	In milk	37	485	2·8
37 Shoesmith ..	,,	22	212	8	,,	22	336	,,	44	548	3·7
44 Reddy ..	—	—	—	10	,,	42	480	,,	42	480	3·8
Countess ..	—	—	—	—	,,	10	187	,,	—	—	4·9
Sandy ..	—	—	—	—	,,	13	138	,,	—	—	4·0
Topsy ..	—	—	—	—	,,	7	83	,,	—	—	3·6
2 Bolter ..	—	—	—	5	,,	47	840	,,	47	840	3·3
9 Tiddlems ..	—	—	—	—	,,	52	711	,,	52	711	3·2
14 Dolly ..	—	—	—	—	,,	52	664	,,	52	664	3·7
24 Pansy ..	—	—	—	—	,,	52	668	,,	52	668	3·4
46 Blossom ..	—	—	—	13	,,	30	462	9	30	462	3·2
Beauty ..	—	—	—	13	,,	35	532	4	35	532	3·5
7 Roan ..	2nd	26	312	17	3rd	9	235	In milk	43	547	3·4
25 Buttercup ..	,,	26	376	8	,,	18	244	,,	44	620	3·7
30 Wallflower ..	,,	22	283	4	,,	26	499	,,	48	782	3·0
50 Rose ..	—	—	—	—	,,	27	464	,,	—	—	3·5
53 Chiddingstone	—	—	—	—	,,	21	367	,,	—	—	3·1
Primrose ..	—	—	—	—	,,	10	219	,,	—	—	3·9
Crumple	—	—	—	—	,,	6	125	,,	—	—	3·1
Roaney ..	—	—	—	—	,,	6	157	,,	—	—	3·6
Mabel ..	—	—	—	—	,,	2	56	,,	—	—	3·8
Tottie ..	—	—	—	—	,,	2	50	,,	—	—	3·8
31 Molly ..	—	—	—	—	,,	52	823	,,	52	823	3·0
5 Polly ..	—	—	—	—	,,	43	739	9	43	739	3·0
41 Cherry ..	—	—	—	9	,,	39	556	4	39	556	3·2
Daisy ..	—	—	—	13	,,	35	458	4	35	458	3·5
Queenie ..	—	—	—	12	,,	31	421	9	31	421	4·0
No. 1 Poll ..	3rd	26	451	9	4th	17	366	In milk	43	817	3·3
16 Brindle ..	,,	6	62	7	,,	39	694	,,	45	756	4·1
20 Nancy ..	,,	22	245	8	,,	22	483	,,	44	728	3·2
21 Darkie ..	,,	26	398	6	,,	20	378	,,	46	776	3·6
49 Snowball ..	—	—	—	—	,,	26	453	,,	—	—	3·0
53 Spot ..	—	—	—	—	,,	39	632	,,	—	—	4·1
Duchess ..	—	—	—	—	,,	12	288	,,	—	—	3·6
Liza ..	—	—	—	—	,,	6	136	,,	—	—	3·5
33 No. 3 Poll	—	—	—	—	,,	39	510	13	39	510	4·0
43 Moaner ..	—	—	—	8	,,	35	509	9	35	509	3·1
11 Dimple ..	4th	2	9	8	5th	42	802	In milk	44	811	3·6
47 Bluebell ..	—	—	—	—	,,	36	709	,,	—	—	3·1
51 Cockhorn ..	—	—	—	—	,,	27	508	,,	—	—	3·4
42 Grannie ..	—	—	—	8	,,	44	753	,,	44	753	3·4
54 Snowdrop 2nd	—	—	—	3	,,	49	674	,,	49	674	3·3
4 Eva ..	—	—	—	—	,,	44	555	8	44	555	4·3
45 Stockings ..	—	—	—	13	,,	35	374	4	35	374	3·9
Adam ..	—	—	—	—	7th	10	187	In milk	—	—	3·0
Jersey ..	—	—	—	—	8th	13	261	,,	—	—	4·9
Average for 30 Cows and Heifers in the Herd throughout the year, or completing one Lactation Period									43	626	3.5

HERD T.

No. of Cow	Lact. Period	Weeks in Milk	Yield of Milk	Weeks Dry	Lact. Period	Weeks in Milk	Yield of Milk	Weeks Dry	Records for the Year: Weeks in Milk	Yield of Milk	Percentage of Fat
			galls.				gals.			gals.	
9 ..	—	—	—	—	1st	52	719	In milk	52	719	3·9
4 ..	2nd	22	351	13	3rd	17	473	,,	39	824	3·0
5 ..	—	—	—	—	2nd	43	501	4	43	501	5·1
8 ..	—	—	—	—	,,	52	851	In milk	52	851	3·4
6 ..	3rd	17	204	9	4th	26	728	,,	43	932	3·3
7 ...	,,	35	520	9	,,	8	271	,,	43	791	3·5
3 ..	—	—	—	9	5th	39	816	4	39	816	3·0
2 ..	—	—	—	—	6th	44	819	4	44	819	3·2
1 ..	—	—	—	—	7th	48	917	In milk	48	917	2·9
Average for 9 Cows and Heifers in the Herd throughout the year, or completing one Lactation Period									45	797	3.5

Table XI.
Summary of Herd Records.

Herd	No. of Cows and Heifers completing the Year or one Lact. Period	Weeks in Milk	Yield of Milk		Percentage of Fat
			Cows and Heifers	Cows only	
A ..	24	36	624	629	3·7
B ..	36	41	686	685	3·8
C ..	34	41	669	675	3·6
D ..	21	44	675	689	3·6
E ..	25	35	611	615	3·3
F ..	39	35	567	582	3·4
G ..	30	40	687	720	3·4
H ..	18	43	604	632	3·7
I ..	22	41	619	612	3·7
J ..	48	42	708	719	3·3
K ..	23	39	636	665	3·3
L ..	27	39	636	685	3·6
M ..	37	37	679	687	3·7
N ..	59	40	686	704	3·4
O ..	26	41	652	671	3·5
P ..	36	43	658	670	3·7
Q ..	52	40	727	751	3·5
R ..	41	41	638	624	3·5
S ..	30	43	626	628	3·5
T ..	9	45	797	807	3·5
Twenty Herds ..	**637**	**40**	**659**	**672**	**3.5**

The total number of Cows under observation was 1,112. 224 were sold during the year, and 251 others did not complete a full year in the Herd. These do not appear in the above table.

THIRD REPORT ON THE COST OF FOOD, IN THE PRODUCTION OF MILK.

INTRODUCTION.

This Investigation on the Cost of Food in the Production of Milk, which is being carried out by the South Eastern Agricultural College, was begun in 1908 with the object of arriving at some reliable estimation of the cost of feeding dairy stock in the South Eastern Counties of England. During the first three winters of the enquiry a large number of farms in Kent and Surrey were visited to collect information on the rations fed to the herds, the amount of milk yielded by the cows fed on those rations, and the cost of the food per gallon of milk produced. The results of this preliminary enquiry are to be found in the First Report which was published by the College in the Autumn of 1910.

A great deal of valuable information was obtained from this preliminary enquiry, but after the publication of the Report an opinion was expressed by several practical farmers, who were consulted on the subject, that more accurate results would be obtained if the Recorder confined his attention to a smaller number of farms, and visited each periodically through the Winter, instead of only paying single visits as had been the custom in the past. Accordingly, on the 1st of January, 1912, twenty farms were selected, and the Milk Recorder visited each farm regularly once a month, weighing the milk of each cow and the food fed to the herd on the evening and morning of his visit. The scheme was extended by taking in the Summer Feeding as well as the Winter Feeding, and the Second Report published in the autumn of 1913 dealt with the twelve months from January 1st, 1912, to January 1st, 1913.

The present Report is a history of the period from February 1st, 1913, to May 1st, 1914. The enquiry was conducted on lines very similar to those of the previous year, but

in order to get more accurate Milk Records every farmer in the scheme undertook to weigh the milk of each cow once a week, in addition to the official weighings of the Recorder.

A very large mass of information on the subject of the Cost of Feeding has now been collected, and in this Report frequent reference is made to figures collected in previous years but which up till now have not been presented, as well as to the work of the current year.

The best thanks of the College are due to the following farmers in Kent and Surrey for their kind assistance, hospitality and advice during the past year. Messrs. L. P. Haynes (East Peckham), W. G. Goodwin (Penshurst), J. G. Goodwin (Tonbridge), J. D. Halliday (Chiddingstone), A. Higgs and A. S. Kelly (Edenbridge), H. Steven (Crockham Hill), W. Alexander (Eynsford), Jas. Lyon, H. Rose and W. G. Thorne (Guildford), J. M. Kelly (Clandon), A. H. Chalmers and G. Oakey (Charlwood), J. H. Beaumont and J. C. Douglas (Betchworth), J. C. Robinson (Horley), T. W. Broom (Dorking), A. H. Moore (Leatherhead), and E. C. Simon (Haslemere).

Objects of the Investigation.

The main object of the enquiry has been to obtain information regarding the Cost of Food in the commercial production of milk. In most Milk Recording Societies established in this country the primary, if not the only, object has been to ascertain the yield and quality of the milk from individual cows, while the cost of feeding has been almost entirely neglected. But while an official "Milk Record Certificate" may be of inestimable value to a pedigree cow in a large sale where export buyers are present, in the case of a commercial herd of non-pedigree cows there is not the same demand for a Certificate which, as the result of "Surprise Visits" and other means to ensure the figures being genuine, can be certified as "Official." A good Dairy Farmer realizes the value of his best cows and will not be tempted to sell them for the £20 to £25 which they might be expected to make in the open market. Nor will he be tempted to sell the heifer calves of his best cows, and it is only in the case of bull calves that the "Official Milk Record Certificate" is of any real value to him. In other words the Milk Records of his

cows will be of more value to himself for his own information in feeding, breeding and weeding out his unprofitable cows than to other people, and there is not the same necessity for close supervision of his Milk Record figures by an outside official as in the case of Pedigree Herds of fashionable strains. To the Commercial Dairy Farmer assistance on the part of the Milk Recorder in weighing the food and working out the Cost of Food in Milk Production with a view to cutting down expenses is quite as important as the actual weighing of the milk. This has been thoroughly recognized in the Wye College Milk Recording Scheme, and the present Report gives some striking illustrations of the value of the work. Many instructive lessons are to be learnt from an intelligent study of the figures given, and it is hoped that the investigation, which is still continuing, will bear fruit by enabling farmers to meet the increasing cost of labour and other items of expenditure by a reduction in their Food Bill without a corresponding reduction in the Milk Yield of their Cows.

Method of the Investigation.

In deciding on the Method to be followed in the continuation of the work it was borne in mind that the Chief Objects of the work were :—

(*a*) To obtain further information as to the Cost of Food in the Production of Milk, and to verify or correct the conclusions drawn from the figures of previous years.

(*b*) To encourage farmers in the keeping of Milk Records with a view to eradicating the unprofitable cows from the herd, rearing calves of the heaviest milkers, and feeding each cow according to her yield of milk.

(*c*) To encourage farmers to weigh the food consumed by their cows in order to avoid wasteful feeding and so reduce the cost of milk-production.

(*d*) To determine the Percentage of Fat in individual or mixed samples of milk.

The testing of the milk of individual cows was carried out in some cases, but it was not specially encouraged. Where milk is used for Butter or Cheese Making the value of the cow to the farmer depends to an appreciable extent on the

quality of the milk, but in the South of England, where milk is produced almost entirely for sale and no higher price is given for milk containing more than the Government Standard of Fat, 3 per cent., there is no encouragement to produce milk containing a higher percentage.

The scheme is based on co-operation between the Farmers and the College. The College Milk Recorder visited each farm at intervals of a month. The Farmers supplied the Recorder with particulars as to the feeding of the cows, and the Recorder weighed the milk of each cow in the herd, evening and morning, and despatched a composite sample of the morning's milk and the evening's milk to the College to be tested. Details of the co-operation of Farmers and College may be summarised as follows :—

Assistance asked of Farmers who joined the Scheme.

Every farmer agreeing to co-operate undertook:

(*a*) To provide himself with a milk-weighing outfit consisting of a spring balance with dial and a special pail.

(*b*) To weigh the milk of all cows in the herd on one morning and evening between Tuesday morning and Saturday morning (both included) of every week.

(*c*) To continue these weighings week by week, always weighing on the same day.

(*d*) To allow the Recorder to weigh the milk at each visit, to examine the figures of the weekly weighings, and to send copies to the College, where they are treated confidentially.

(*e*) To supply or assist in supplying an accurate report on the food consumed by the cows and the prices of the foods fed.

(*f*) To give particulars, where possible, as to the breed, age, number of calves, dates of calving, service and drying off of each cow.

(*g*) To allow the Recorder to obtain representative samples of the milk from each cow, evening and morning, or of the mixed milk.

(*h*) To afford the Recorder board and lodging for one night each month. The Recorder to arrive at every farm in time for the afternoon milking.

The College undertook :—

(*a*) To give the farmer a monthly report following the visit of the Milk Recorder stating :—

(i) The number of cows in milk, the total yield on the day of the Recorder's visit and the average yield of milk per cow in the herd.

(ii) The quantity of food being fed per cow, the composition of the ration and the cost of food per cow per day and per gallon of milk yielded.

(iii) The Scientific Food Requirements of the Cows, and if desired by the farmer remarks as to how the ration being fed can be brought into line with the Scientific Requirements.

(iv) The quality of the morning's and evening's milk of the herd.

(v) A comparison of the herd's daily yield per cow, cost per day, cost per gallon and quality of the milk, with the average of all the farms in the scheme during the last Round of the Recorder.

(A specimen copy of this monthly statement appears on page 82.)

(*b*) To give the farmer an annual report as to the yield of milk produced by each cow in the herd. This report to be based on the weekly weighings of the farmers and the monthly weighings of the Recorder.

(*c*) To supply the bottles necessary for all samples of milk, and to pay the postages from the College to the farms. The farmers pay the postage on the full samples from the farms to the College.

(*d*) To send to the farmers a copy of all printed reports on the results of the Investigation. All information supplied is kept strictly private as between each individual farmer and the College, and in all Reports the farms are distinguished by letters or numbers.

(*e*) To give information and advice as to the properties of new foods, and the compounding of rations.

In addition to affording the Milk Recorder board and lodging for one night each month every farmer in the scheme

agreed to subscribe at the rate of 1s. per cow per annum towards the cost of the scheme and to pay 1d. for every sample of milk tested for butter fat.

The visits of the Recorder were continued as nearly as possible at monthly intervals throughout the year. Where his visits coincided with the day of the weekly weighing of the milk his figures took the place of the ordinary figures. When his visit did not coincide with the usual day of weighing his figures were used as supplementary to the weekly figures. For the post of Recorder the College was able to retain the services of Mr. R. G. Chandler throughout the year, and he is to be congratulated upon the success of the practical side of the Investigation.

PART I.

COST OF FOOD IN THE PRODUCTION OF MILK.

PART I

COST OF FOOD IN THE PRODUCTION OF MILK.

The year naturally falls into two periods, the Winter Period when the cows are on full indoor feeding, and the Summer Period when the cows are entirely or mainly on grass, and the results will be stated and discussed in the three sections as follows :—

Section A.—Cost during the Winter Period.

Section B.—Cost during the Summer Period.

Section C.—Cost during the Complete Year.

In dividing the year up into a Winter Period and a Summer Period a difficulty immediately arises in fixing the dates on which each period shall begin and end. The date on which cows first go out to grass in the Spring will vary with the season, the district, and even with the individual farm, whilst in the autumn there is never any sudden change from Summer Feeding to Winter Feeding, so that it is impossible to fix on any two clearly marked Winter and Summer Periods which will apply to every farm and every season. The only satisfactory method is to watch the returns as they come in from every farm, and consider the Summer Period to commence directly there is a sudden drop in the cost of Indoor Feeding, and similarly when, in the autumn, there is a sudden rise in the cost of Indoor Feeding to consider that the Summer Period has come to an end. During the year under consideration the average figures of Cost of Indoor Feeding for each Round made by the Milk Recorder were as follows :—

TABLE I.

COST OF INDOOR FEEDING, FEBRUARY 1ST, 1913, TO APRIL 16TH, 1914.

		No. of Farms.	No. of Cows in Milk.	Daily Yield per Cow.	Cost of Food per Cow per day.	Cost of Food per gall. Milk.	Average percentage of Fat.	
				galls.	pence.	pence.	A.M.	P.M.
1st Round	Feb. 1 to Feb. 28	16	526	2.26	13.37	6.01	3.3	3.8
2nd ,,	Mar. 1 to April 1	16	540	2.28	13.12	5.90	3.4	4.0
3rd ,,	April 3 to April 29	17	615	2.35	11.84	5.18	3.4	3.9
4th ,,	April 30 to June 2	17	578	2.62	3.01	1.14	3.3	3.8
5th ,,	June 3 to July 3	17	585	2.59	1.61	0.61	3.1	3.7
6th ,,	July 4 to Aug. 2	17	595	2.29	1.64	0.70	3.2	3.9
7th ,,	Aug. 2 to Sept. 2	17	583	2.30	2.05	0.83	3.2	4.0
8th ,,	Sept. 3 to Oct. 1	17	592	2.17	2.93	1.29	3.2	3.9
9th ,,	Oct. 1 to Nov. 4	18	621	2.19	4.10	1.87	3.1	3.9
10th ,,	Nov. 5 to Dec. 4	18	625	2.23	10.09	4.54	3.1	3.9
11th ,,	Dec. 5 to Jan 13	18	634	2.28	12.87	5.67	3.3	3.9
12th ,,	Jan 13 to Feb. 17	18	636	2.29	12.33	5.43	3.3	4.1
13th ,,	Feb. 17 to Mar. 12	18	618	2.36	13.53	5.85	3.3	3.8
14th ,,	Mar. 12 to April 16	18	637	2.40	13.45	5.61	3.3	3.9

There were two other farms in the scheme throughout the year in addition to those shown in the above table. One was a Jersey herd and the other a Guernsey herd, but the figures are not included because they can hardly be considered commercial herds and their inclusion would have an unnatural effect on the average cost of feeding.

It will be seen that there is a distinct drop in the cost of Indoor Feeding between the third round (April 3rd to April 29th), and the fourth round (April 30th to June 2nd) and a corresponding increase between the ninth round (October 1st to November 4th) and the tenth round (November 5th to December 4th). Obviously the sudden drop in the cost

of Indoor Feeding is due to the cows going out to grass, so that the Summer Period for the year 1913 may be considered to begin on or about May 1st and to conclude on or about November 1st. The year is thus divided into two equal periods of twenty-six weeks each, and these two periods coincide fairly closely with the two periods during which farmers receive Summer prices and Winter prices for their milk.

In the last Report, dealing with the year January 1st, 1912, to February 1st, 1913, a Summer Period of twenty-eight weeks was taken. The reason of this was that in that year the grass was ready for feeding rather earlier in the Spring and continued growing late in the Autumn. The average figures for the various rounds were as follows :—

TABLE II.

COST OF INDOOR FEEDING, DECEMBER 20TH, 1912, TO JANUARY 29TH, 1913.

			No. of Farms.	No. of Cows in Milk.	Daily yield. per Cow.	Cost of Food per Cow per day.	Cost of Food per gall. Milk.
					galls.	pence.	pence.
1st	Round	Dec. 20 to Feb. 1	20	723	2.09	15.20	**7.27**
2nd	,,	Feb. 2 to Mar. 7	20	725	2.09	14.68	**7.02**
3rd	,,	Mar. 8 to April 21	20	746	2.12	12.12	**5.72**
4th	,,	April 22 to May 20	20	716	2.44	4.36	**1.79**
5th	,,	May 21 to June 18	20	703	2.30	1.82	**0.79**
6th	,,	June 19 to July 25	20	692	2.19	1.48	**0.67**
7th	,,	July 28 to Aug. 26	20	657	2.17	2.46	**1.13**
8th	,,	Aug. 29 to Sept. 22	20	675	2.18	2.77	**1.27**
9th	,,	Sept. 25 to Oct. 21	20	690	2.25	3.99	**1.77**
10th	,,	Oct. 24 to Nov. 25	19	717	2.06	9.58	**4.66**
11th	,,	Nov. 25 to Dec. 23	19	727	2.07	12.21	**5.90**
12th	,,	Dec. 28 to Jan. 29	19	709	2.11	12.74	**6.14**

In this case there was a sudden drop in the cost of Indoor Feeding between the round commencing on March the 8th, and ending on April 21st, and the next round commencing on April 22nd, so that the grass began to become an important feed some time during the month of April. Similarly the cost of Indoor Feeding rose from 1·77d. per gallon of milk in the ninth round (September 25th to October 21st) to 4·66d. per gallon of milk in the tenth round (October 24th to November 25th) so that the Outdoor Feeding ceased to be of any importance during the month of November. At the same time it will be noticed that in both years the Indoor Feeding during the month of November is not so expenisve as during December, the cows evidently still getting something from their outdoor grazing.

It will thus be seen that there is considerable difficulty in drawing a dividing line between the Winter Period and Summer Period on a collection of farms. The dividing line varies as a matter of fact from farm to farm according to the earliness of the grass, and from season to season. It is intended in the future to keep an account of the date on which the cows on each individual farm first stay out at night and similarly the date on which they first come in, and in that way it is hoped to get a more reliable basis to work from. An alternative plan which has been suggested is to take the dates on which the Summer Contracts and Winter Contracts for milk begin and end, work on that basis irrespective of the season and the farm, and so assist a farmer in getting, over an average of seasons, a comparison between the cost of production and the price he is getting for each period. The difficulty in that case would be that the whole of the cost of the grass would have to be charged to the period covered by the Summer Milk Contract and, seeing that the Grazing plays an important part in feeding during the whole of October and frequently during a large part of November, the result would not be a fair statement. It seems impossible at present to devise a method for dividing the value of the grass over the different months of the year.

Section A.—Cost during the Winter—1st November to 1st May (26 weeks).

The period properly covered by this Report begins on February 1st, 1913, and concludes on May 1st, 1914. On February 1st, nine of the farmers who were in the scheme during the previous year dropped out, and nine new ones took their places. Of the eleven farmers who remained in the scheme complete figures are available for two years, and it will be best to deal with these first.

It has already been stated that in the year 1912-1913, a Winter Period of twenty-four weeks was taken, whilst in the year 1913-14, a Period of twenty-six weeks was found to be more accurate. In order to get a truer comparison between the two years a Winter Period from November 1st to May 1st has been taken in each case. The Milk Recorder visited each farm once a month so that the cost of Winter Feeding has been calculated from six visits paid to each farm during each winter. It would obviously be unfair to compare the cost of feeding on one farm visited in the first week of November with another farm visited in the last week of November, because the first farm would probably be taking advantage of the grass and giving less food indoors. Similarly the cost of feeding on a farm visited on April 2nd cannot be fairly compared with another farm visited on April 29th when the cows are beginning to get a bite of grass. To get really accurate comparisons every farm should be visited on the same day, but that of course is impossible. To get over the difficulty as far as possible the Food Records for each farm have been worked out from the weight of foods calculated to have been fed on the middle day of each month. In other words, the cost of Winter Feeding, from 1st November to 1st May, has been worked out from calculated weighings for mid-November, mid-December, mid-January, mid-February, mid-March, and mid-April. One farmer, for instance, was feeding on November 4th, 5 lbs. hay, 1 lb. wheat-meal, 1 lb. oatmeal, 2 lbs. Egypt cotton cake, and 2 lbs. Silcocks dairy meal. On the Milk Recorder's next visit on December 4th he was feeding

25 lbs. cabbages, 25 lbs. white turnips, 5 lbs. hay, 5 lbs. oat straw, 3 lbs. Egypt cotton cake, $1\frac{1}{2}$ lbs. Silcocks dairy meal and 1 lb. mixed meals. It would not be fair in such a case to take either record as a typical ration for the month, and an average of the two was taken as representing the November Feeding. Farmers in the scheme have always been encouraged to state the dates on which they alter their feeding so as to enable as accurate accounts as possible to be kept.

Valuation of the Foods Used.

In valuing the home-grown foods the same prices are charged as were used in the last Report :—

Mangels and Swedes	..	..	10s.	per ton.
Turnips	..	..	8s.	,,
Hay	..	..	60s.	,,
Oat Straw	..	..	40s.	,,
Barley Straw	..	..	25s.	,,
Chat Potatoes	..	..	20s.	,,

Exception may be taken to some of these figures, but it is unnecessary to repeat the arguments in justification of them which will be found on pages eight and nine of the last Report. It is generally agreed by all who have taken part in any investigation of this kind that home-grown foods should be valued at Cost of Production and not at Market Prices. In reality foods like mangel have no definite Market Value, because if every farmer put his mangels on to the market there would be practically no sale for them. The fact that mangels or hay would make 15s. or 90s. a ton on the farm if put up for sale is therefore not sufficient reason for charging them at these prices to the cows.

The charging of Costs of Production instead of Market Values will not result in any losses or profits to the farm, but simply concentrate them on the cows. The question whether it would have been more profitable to sell some o the foods instead of feeding them, or conduct the business along some other line is a proper subject for study at the close of the year's work, and detailed figures should be available for that

purpose, but the farm accounts should show how the business was actually conducted, and not how it might have been.

To get the most accurate figures for each farm the best plan would undoubtedly be to take the actual cost of producing a ton of mangels, swedes, etc., on each individual farm, but the original object of this work was to investigate the Cost of Food in the Production of Milk and not the Cost of Producing Food. The Investigation begins at the cowshed and not in the field, and to start right at the beginning on each farm, though excellent in theory, is unfortunately, with the writer's present resources, more than he has been able to undertake. Instead, therefore, of taking the actual cost of production of each home-grown crop on each individual farm, the farmers were asked to suggest the average cost of production in an average year. The mean of all the figures named was then taken as the average cost of production of each crop.

All purchased foods are charged at the cost price, plus an allowance for cartage to the farm. It has been suggested that the Manurial Values of purchased foods should be allowed for. If this were done it would reduce the cost of the Winter Feeding of Cows by about 1¼d. per day (equivalent to ½d. per gallon of milk), and the cost of the Summer Feeding by about ⅔d. per day (equivalent to ¼d. per gallon of milk), or an average reduction of 1d. per day for food throughout the year, and ⅔d. per gallon of milk produced. The reduction, however, has not been made because a farmer does not expect to have to look to the manure for the profit on his cows.

Method of Calculation.

In making the calculations for the individual farms only the foods fed to the cows actually in milk were included. The foods fed to dry and fattening cows were not taken into account, as it was considered that the value or the sale price of a fat cow or of the calf would on the whole give a return balancing the cost of the foods used when the cows were dry.

In the working out of the figures in this Report it must be remembered that the Milk Recorder only visited each farm once a month. The quantity of milk produced in the twenty-four hours covered by the Recorder's visit was taken

as the average daily yield of the herd during the month. This figure, together with the calculated cost of food for the day and the number of cows in milk, supplied the data for the determination of :—

(*a*) The Average Daily Yield per Cow.
(*b*) The Average Cost of Food per Cow per Day, and
(*c*) The Average Cost of Food per Gallon of Milk.

The method of comparing the figures of one visit with the next so as to get a fair average for the middle of the month has already been described.

COMPARISON OF TWO WINTERS.

The results calculated for each of the eleven farms that have been in the scheme for two years are given in Table III.

TABLE III.

11 Farms. Winter, 1912-13; 26 weeks (November 1st to May 1st).

Herd.	No. of Cows in Milk.	Daily Yield per Cow.	Cost of Food per Cow per day.	Cost of Food per gall. Milk.	Average Daily Rations.				
					Roots.	Hay.	Straw.	Wet grains.	Cakes and Meals.
		galls.	pence.	pence.	lbs.	lbs.	lbs.	lbs.	lbs.
C	30	2.17	9.33	**4.30**	36	3	7¼	nil	7.0
I	32	1.86	9.73	**5.23**	21	½	4	8	9.6
R	53	2.23	11.75	**5.27**	50	8	5¼	nil	6.2
K	32	2.06	11.16	**5.42**	37	10½	1¾	nil	7.7
B	43	2.28	12.54	**5.50**	70	8	5½	15	5.1
O	23	2.33	13.35	**5.73**	34	12	nil.	nil	7.5
M	54	2.14	12.43	**5.81**	78	5	2	11½	6.7
P	44	1.85	10.99	**5.94**	65	nil	10¾	nil	7.1
Q	55	2.24	14.13	**6.31**	71	4	8¼	nil	10.9
L	26	1.90	12.29	**6.47**	60	11	5	15	3.8
A	23	2.33	17.38	**7.46**	99	9½	7½	nil	9.1
Av'ge	**37**	**2.13**	**12.29**	**5.77**	**56**	**6½**	**5¼**	**4½**	**7½**

The same 11 Farms. Winter, 1913-14; 26 weeks (November 1st to May 1st).

Herd.	No. of Cows in Milk.	Daily Yield per Cow.	Cost of Food per Cow per day.	Cost of Food per gall. Milk.	Average Daily Rations.				
					Roots.	Hay.	Straw.	Wet Grains	Cakes and Meals
		galls.	pence.	pence.	lbs.	lbs.	lbs.	lbs.	lbs.
K	34	2.16	10.21	4.72	42	6	5½	nil	7.9
R	52	2.13	10.16	4.77	50	9	4	nil	6.0
B	44	2.20	10.58	4.80	65	6¼	4½	10¼	4.4
Q	47	2.49	11.95	4.80	60	7¾	8½	nil	8.3
O	23	2.53	12.22	4.82	46	10	3¼	nil	9.0
C	31	2.10	10.26	4.88	26	11¾	nil	nil	7.4
L	30	2.08	10.84	5.20	48	10¾	4½	14½	3.9
P	35	2.24	12.17	5.43	69	7	10¼	nil	4.7
A	23	2.28	12.62	5.53	44	10½	4	nil	8.1
M	55	2.32	14.64	6.30	51	6½	1¾	24¾	10.5
I	29	1.58	11.21	7.08	54	7¼	3½	9¼	5.6
Av'ge	37	2.19	11.61	5.30	50	8	4½	5	7

The results are closely comparable except in the case of Farms I and M, which have changed hands. The herds of cows are the same, but the owners are different. In the case of Farm I there was a misunderstanding between the new owner and the previous one as to which cows were in calf and the dates on which the various cows were due to calve down. The result was that many cows thought to be in calf turned out not to be so, and the yield of milk suffered in consequence.

On comparing the sets of figures for the two years it will be seen that during the winter of 1913-14 the farmers in the Scheme were able to produce their milk at nearly ½d. per gallon less than in 1912-13. The Daily Yield of Milk is in favour of 1913-14 (2.19 gallons a day), and so is the Daily Cost of Feeding (11.61d. per day), whilst a comparison of the

prices of the various concentrated foods given in Table V. will show that foodstuffs were a good deal cheaper in 1913-14 than they were in 1912-13. Under the circumstances it is rather surprising that there is not more difference in the Cost of Production between the two years, but a study of the following figures, showing the quantities and costs of the different foods consumed by each cow during the Winter, will show that variation in the market prices of the concentrated foodstuffs does not have so marked an effect on the cost of feeding as is often supposed.

TABLE IV.

Average Quantity and Costs of the Foods fed per Cow during the Winter.

1912-13.	£	s.	d.		1913-14.	£	s.	d.	
Root Crops, 4.75 tons at 10/1	2	7	10	(26%)	4.24 tons at 10/2	2	3	0	(24%)
Fodder Crops, 18.54 cwt. at 49/-	2	5	11	(25%)	20.59 cwt. at 52/2	2	13	11	(31%)
Wet Grains, 7.42 cwt. at 19/3		7	2	(3%)	9.97 cwt. at 17/10		8	11	(4%)
Concentrated Foods, 12 cwt. at 136/-	4	1	6	(45%)	11.24 cwt. at 129/-	3	12	9	(41%)
Total Cost per Cow ..	£9	2	5		Total per Cow ..	£8	18	7	

It is true that the Concentrated Foods, including Wet Grains, are responsible for nearly a half of the cost of feeding the cows, but the other half of the cost of feeding lies in the home-grown foods—the Root Crops and Fodder Crops. Many farmers fail to realize how largely their cost of feeding is dependent on the cost of production of their Root and Fodder Crops. If we take the figures for 1912-13 as representative of the feeding of cows in general it will be seen that 4¾ tons of Roots are consumed for every 12 cwt. of Concentrated Food, or a proportion of eight parts by weight of Roots to one part of Cakes and Meals. An increase or decrease of a shilling a ton in the cost of production of the Root Crop is therefore equivalent to an increase or decrease of 8s. a ton in the cost of the Concentrated Foodstuffs so far as the cost of feeding the cows is concerned. A rise of 8s. a ton in the price of purchased foodstuffs is always looked

on as a serious matter—as indeed it is—but this corresponds to a rise of only 1s. a ton in the cost of production of the Root Crops. In one year a farmer may get a crop of 30 tons mangels to the acre at a cost of £10 (6s. 8d. per ton); in another year he may only get a crop of 15 tons at the same cost of £10 (13s. 4d. per ton). Such a condition of affairs, representing a rise of 6s. 8d. per ton in the cost of mangels, is far more serious than a rise of 8s. in the cost of purchased foodstuffs—it corresponds in fact to a rise of 52s. 8d. per ton in the price of concentrated foodstuffs—and the necessity for a farm to be capable of growing large crops of Roots, Straw and Hay in order to produce milk cheaply is not sufficiently understood. The figures of this Report cannot illustrate that fact very clearly, because the cost of production of home-grown foods is estimated at the same amount on every farm. If it were possible to calculate every farm on actual cost of production, and to compare different seasons, some very striking figures would probably appear.

Quantities of Foods Fed.

Table V. shows the Total Amount of the Different Foods Fed on these eleven farms during the two seasons. The two sets of figures represent the same Winter Period (1st November to 1st May), and the number of cows was very nearly the same in each case, 412 cows in 1912-13 and 403 cows in 1913-14. It will be noticed that the average cost of the Root Crops is 1d. per ton higher in 1913-14 owing to a rather larger quantity of Potatoes being fed in that year, and Fodder Crops are 3s. 2d. per ton higher owing to more Hay being fed and less Straw.

The feeding of Oat Straw in the place of Hay is an important factor in the cost of feeding, especially in a winter following a dry summer when the hay crop has been short and therefore expensive to produce or to purchase. Hay at £4 15s. per ton for example is equivalent to ½d. per lb., and if in a bad hay year farmers realized, when they saw good hay being trodden under foot in the farmyard, that for every pound that is being wasted they are losing ½d. out of their trousers pocket, a little more care would probably be taken in the feeding of this material. One of the reasons why

TABLE V.

TOTAL QUANTITIES OF FOOD FED.

ELEVEN FARMS, 26 WEEKS WINTER PERIOD (1ST NOV. TO 1ST MAY).

	1912-13. (412 Cows).					1913-14. (403 Cows).				
	Quantity	Price per ton.	Total Cost.			Quantity	Price per ton.	Total Cost.		
	tons.		£	s.	d.	tons.		£	s.	d.
Root Crops—										
Mangels ..	1600	10/–	800	0	0	1340	10/–	670	0	0
Cabbages ..	165	10/–	82	10	0	227	10/–	113	10	0
Swedes ..	136	10/–	68	0	0	65	10/–	32	10	0
Turnips ..	32	8/–	12	16	0	41	8/–	16	8	0
Swede Tops ..	10	10/–	5	0	0	—	—	—		
Chat Potatoes ..	17	20/–	17	0	0	35	20/–	35	0	0
Total ..	1960	10/–	985	6	0	1708	10/2	867	8	0
Per Cow ..	*4.75*	—	*£2*	*7*	*10*	*4.24*	—	*£2*	*3*	*0*
Fodder Crops— ..										
Hay ..	203	60/–	609	0	0	265	60/–	795	0	0
Oat Straw ..	140	40/–	280	0	0	113	40/–	226	0	0
Wheat Straw ..	20	25/–	25	0	0	11	25/–	13	15	0
Hay and Straw Chaff	7	40/–	14	0	0	—	—	—		
Oat and Bean Chaff	2	40/–	4	0	0	—	—	—		
Oat and Wheat Chaff	10	30/–	15	0	0	—	—	—		
Pea Straw ..	—	—	—			5	40/–	10	0	0
Bean Straw ..	—	—	—			21	40/–	42	0	0
Total ..	382	49/–	947	0	0	415	52/2	1086	15	0
Per Cow ..	*18.54 cwt.*	—	*£2*	*5*	*11*	*20.59 cwt.*	—	*£2*	*13*	*11*
Wet Grains— ..	153	19/3	147	3	0	201	17/10	179	18	0
Per Cow ..	*7.42 cwt.*	—	*£0*	*7*	*2*	*9.97 cwt.*	—	*£0*	*8*	*11*
Concentrated Foods—										
Maize Gluten Feed	44.4	144/–	316	14	6	55.2	132/–	363	14	0
Bean Meal ..	16.3	179/–	143	11	0	6.5	146/–	47	15	6
Egypt Cotton Cake	34.6	122/–	213	0	6	20.7	114/–	120	9	0
Dried Grains ..	19.8	116/–	116	11	0	17.2	113/–	96	16	0
Distilled Grains ..	—	—	—			8.0	128/–	51	5	0
Bombay Cotton Cake	21.2	115/–	121	0	0	10.0	94/–	47	5	0
Bran ..	18.0	114/–	102	18	0	5.6	96/–	26	10	6
Maize Meal ..	14.2	141/–	98	17	0	1.7	125/–	10	12	6
"Cow Rations" ..	7.7	161/–	62	0	0	—	—	—		
Dec. Cotton Cake ..	7.1	171/–	60	0	0	13.5	169/–	114	4	6
Silcock's Dairy Meal	7.4	154/–	57	3	0	2.5	146/–	18	6	6
Bastol	9.4	110/–	51	7	0	2.2	120/–	13	4	6
Middlings ..	6.5	127/–	41	6	0	4.5	120/–	27	0	0
Linseed Cake ..	4.5	170/–	38	5	0	16.3	157/–	127	18	0
Maize Germ Meal ..	5.5	140/–	38	10	0	6.3	127/–	40	0	6

TABLE V. (contd.)

	1912-13. (412 Cows).			1913-14. (403 cows).		
	Quantity	Price per ton.	Total Cost.	Quantity	Price per ton.	Total Cost.
	tons.		£ s. d.	tons.		£ s. d.
Silcock's Dairy Cake	3.8	140/-	26 1 6	—	—	—
Soya Cake ..	2.9	161/-	24 4 0	.7	160/-	5 11 6
Molbran ..	3.3	134/-	22 1 0	7.5	104/-	39 7 6
Homco	2.5	159/-	19 18 0	—	—	—
Mixed Meals ..	2.6	140/-	18 3 0	—	—	—
"Excelsior" ..	2.3	147/-	16 17 0	—	—	—
Union Cotton Cake	2.2	128/-	14 1 0	7.9	125/-	50 1 6
Union Dairy Cake..	1.5	140/-	10 8 0	3.3	135/-	22 5 6
Shirley Meal ..	1.2	162/-	9 14 0	—	—	—
Gram ..	1.2	125/-	7 10 0	—	—	—
Tail Wheat and Oats	1.0	145/-	7 5 0	—	—	—
Treacle	1.5	97/-	7 6 0	.8	101/-	4 1 0
Soya Meal ..	.8	164/-	6 11 0	—	—	—
Cocoanut Cake ..	3.0	159/-	10 7 0	—	—	—
Treacle Soya Cake ..	1.1	111/-	6 2 0	—	—	—
Bastol Cake ..	.7	157/-	5 10 0	—	—	—
Crushed Oats ..	.4	152/-	3 1 0	17.2	152/-	128 19 6
Barley Meal ..	.3	143/-	2 3 0	—	—	—
Oat Husks ..	—	—	—	5.4	70/-	18 18 0
Sugar Pulp ..	—	—	—	.7	107/-	3 15 0
Cotton Screenings ..	—	—	—	2.3	70/-	8 0 6
Wheat Meal	—	—	—	2.7	144/-	19 9 0
Bibby Cake ..	—	—	—	6.4	162/-	51 14 0
Stanley Dairy Cake	—	—	—	1.4	138/-	9 13 0
Total ..	247.2	136/-	1678 5 0	226.5	129/-	1466 17 6
Per Cow ..	*12 cwt.*	—	*£4 1 6*	*11.24 cwt.*	—	*£3 12 9*

Hay is such a good food is that cows must have a quantity of bulky fodder to enable them to chew the cud, and Hay supplies that requirement. But so does Oat Straw, and where Oat Straw is available and is appreciably less costly than Hay it is suggested that a half of the Fodder supplied might profitably be given in the form of Oat Straw.

Cakes and Meals were decidedly less expensive in 1913-14 than in 1912-13, there being a decrease of from 6s. to 10s. per ton in the price of practically every food. The Cost per Cow was less in consequence.

The remaining Nine Farms, which were in the Scheme during the past year, joined on February 1st, 1913, so that

it is impossible in their case to give the figures for the complete Winter of 1912-13.

RESULTS FOR THE WINTER, 1913-14.

During the whole of the Winter of 1913-14, *i.e.*, from November 1st, 1913, to May 1st, 1914, there were twenty herds in the scheme. Eighteen of these were Shorthorn herds, one consisted of Jersey Cows and the other of Guernseys. In Table VI. these two Channel Island Herds are kept separate from the others. For the commercial sale of milk Jersey and Guernsey Herds cannot as a rule be considered profitable unless an extra charge is made for the milk, so that in averaging out costs of production these two herds are kept apart from the others. The figures for the Six Winter Months were as follows :—

The average Daily Yield of Milk is 2.26 gallons, the average Cost of Food per Day 12.12d. and the Cost per Gallon of Milk, 5.36d.

On looking through the table it will be seen that one farm (AA) is producing milk at 4.21d. per gallon for food, whilst on another farm it is costing 7.08d. And yet on both these farms Roots, Hay and Straw are being valued at the same prices and each had the same opportunity of buying the same Concentrated Foods at practically the same prices in the open market. Surely under those conditions if eight farms can produce milk at less than 5d. per gallon, the other ten farms ought to be able to do the same. But there are four farms where the milk is costing more than 6d. a gallon, and one farm where it is costing more than 7d. a gallon for food alone.

A common-sense principle that should underlie every system of feeding is that Cows shall be fed according to the amount of milk that they yield. The more that is taken out of a cow the more should be returned; in other words, the heavier she milks the more should she be fed, and *vice versa.* A glance at the table will show that this principle is not always put into practice. Herd AA, for example, is the heaviest milking herd in the series, and yet there are no less than nine farms where the cost of feeding is higher per day than on this particular farm. Take, on the other hand,

TABLE VI.

Results from Twenty Farms, Winter 1913-14, Twenty-six Weeks (1st Nov. to 1st May).

Herd.	No. of Cows in Milk.	Daily Yield per Cow.	Cost of Food per Cow per day.	Cost of Food per Gallon of Milk.	Average Daily Rations.				
					Roots.	Hay.	Straw.	Wet Grains.	Cakes and Meal.
		gallons	pence.	pence.	lbs.	lbs.	lbs.	lbs.	lbs.
AA	25	2.56	10.79	4.21	60	7.1	3.7	9.8	4.8
K	34	2.16	10.21	4.72	42	6.1	5.6	—	7.9
R	52	2.13	10.16	4.77	50	9.0	4.1	—	6.0
B	44	2.20	10.58	4.80	65	6.2	4.5	10.2	4.4
Q	47	2.49	11.95	4.80	60	7.7	8.6	—	8.3
O	23	2.53	12.22	4.82	46	9.9	3.2	—	9.0
AB	57	1.97	9.56	4.85	77	6.1	4.6	—	4.0
C	31	2.10	10.26	4.88	26	11.8	—	—	7.4
L	30	2.08	10.84	5.20	48	10.7	4.5	14.4	3.9
AC	20	2.40	12.65	5.26	48	9.9	4.7	—	8.3
AD	32	2.52	13.57	5.38	37	16.4	·3	—	9.5
P	35	2.24	12.17	5.43	69	6.9	10.2	—	4.7
A	23	2.28	12.62	5.53	44	10.6	4.1	—	8.1
AE	25	2.44	13.83	5.67	62	8.3	5.1	—	8.9
AF	21	2.36	14.45	6.11	34	15.7	—	—	9.9
M	55	2.32	14.64	6.30	51	6.4	1.7	24.7	10.5
AG	49	2.29	15.31	6.68	70	13.7	1.4	15.9	8.3
I	29	1.58	11.21	7.08	54	7.2	3.4	9.3	5.6
Average of 632 Cows		2.26	12.12	5.36	52	9.4	3.9	4.7	7.2
Guernsey	20	1.60	12.57	7.87	29	16.5	—	—	7.5
Jersey	18	1.35	9.23	6.84	29	8	4	—	5.4

Herd I at the bottom of the Table. This herd is giving the lowest yield of milk but there are six other farms where the cost of feeding per day is less. The herd at the top of the Table is averaging nearly a gallon of milk per head per day more than the herd at the bottom of the Table, and is costing 0.42d. per head per day less to feed. Both are receiving practically the same quantities of Roots, Hay, Straw and Wet Grains, but the low yielding herd is receiving about $\frac{3}{4}$ lb. cake per head per day more. Another example of over-feeding will be seen by comparing Herd AG with Herd A. Herd A is costing nearly $2\frac{3}{4}$d. per head per day less and is giving practically the same amount of milk. It should, however, be remembered that one ration may cost less than another and yet contain more nutriment, because of the cheaper buying of Concentrated Foods. A study of Table XXII. affords illustrations of this.

If all the Winter figures that are now available for the last two years are split up into three sets—Set I. those herds giving the cheapest milk, Set III. those herds giving the expensive milk, and Set II. those intermediate—we get the series of figures shown in Table VII. (page 25).

It will be noticed that in every case as the Milk Yield per Cow goes down the Daily Cost of Feeding per Cow goes up, the exact opposite to what it should do. It is difficult to find any explanation which will justify this state of affairs.

With so many factors involved it is impossible to discover any single factor responsible for high costs of feeding on individual farms beyond the general statement of Over Feeding and Poor Milk Yields. It cannot, for instance, be traced to any single foodstuff. A larger quantity of Roots, Hay and Concentrated Foods all seem to be connected with extravagant feeding, but nothing very outstanding makes itself apparent.

Taking each farm individually for the Winter of 1913, the following comments on the causes of high costs and low costs may possibly be suggestive.

Causes of Low Cost.

Herd AA. Heavy yielding cows (2.56 gallons per day), combined with very economical feeding are the cause of this

TABLE VII.

Comparison of Winter Costs.

	Daily Yield per Cow.	Cost of Food per Cow per day.	Cost of Food per Gallon of Milk.	Average Daily Ration. Roots.	Hay.	Straw.	Wet Grains.	Cakes and Meals.
	gallon.	pence.	pence.	lbs.	lbs.	lbs.	lbs.	lbs.
11 Farms, Winter, 1912-1913.								
4 Cheap Herds ..	2.29	11.02	4.81	47	7.7	4.4	3.7	6.4
4 Intermediate ..	2.09	12.49	5.98	62	4.7	5.7	2.9	8.1
3 Expensive Herds ..	2.06	12.92	6.27	60	7.0	5.5	7.7	7.5
19 Farms, Nov. and Dec., 1912.								
7 Cheap Herds ..	2.26	10.34	4.69					
6 Intermediate ..	2.05	11.62	5.65	No	figures	availa	ble	
6 Expensive Herds ..	1.92	14.87	7.69					
21 Farms, Jan. to Mar., 1913.								
7 Cheap Herds ..	2.24	12.19	5.45	43	8.3	5.6	17.8	5.5
7 Intermediate ..	2.05	15.13	7.37	50	10.6	11.0	8.2	7.9
7 Expensive Herds ..	2.02	16.82	8.35	56	15.0	7.2	18.7	6.5
18 Farms, Winter, 1913-1914.								
6 Cheap Herds ..	2.35	10.98	4.68	54	7.7	4.9	3.3	6.7
6 Intermediate ..	2.22	11.51	5.17	51	10.3	4.0	2.4	6.3
6 Expensive Herds ..	2.21	13.68	6.23	52	10.3	2.6	8.3	8.
Average of all the above								
24 Cheap Herds ..	**2.28**	**11.13**	**4.91**	**48**	**7.9**	**5.0**	**8.3**	**6.2**
23 Intermediate ..	**2.10**	**12.69**	**6.04**	**54**	**8.5**	**6.9**	**4.5**	**7.4**
22 Expensive Herds ..	**2.05**	**14.57**	**7.13**	**56**	**10.8**	**5.1**	**11.6**	**7.5**

herd being at the top of the table. The "Roots" fed consisted very largely of Cabbages. A small allowance of Wet Grains was fed, and the Concentrated Foods consisted chiefly of Barley Meal, Maize Meal, Wheat Meal and Maize Gluten Feed. The Straw was half Oat Straw and half Pea Straw. A small quantity of Cocoanut Cake was fed, this being the only farm that made use of that particular food.

Herd K. This farm owes its position chiefly to its Low Cost of Feeding (10.21d. per day). There are several Dutch Cows in the herd and the quality of the milk is not always entirely satisfactory. No Cabbages at all were fed on this farm, the Roots being all in the form of Mangels. The chief Concentrated Foods were Decorticated Cotton Cake, Beans and Oat Husks. Smaller quantities of Maize Gluten Feed, Dried Grains, Maize Germ Meal and Soya Meal were fed.

Herd R. The Cost of Feeding (10.16d. per day) was lower, with one exception, than in any other Herd in the round. A very large variety of foods were fed, including Mangels, Cabbage, Swedes, Turnips, Meadow Hay, Clover Hay, Oat Straw, Wheat Straw, and eleven different kinds of Concentrated Foods, the principal one being Egyptian Cotton Cake.

Herd B. An average yield of milk was combined with economical feeding (10.58d. per day). It will be noticed that the amount of Concentrated Food fed per Cow per day only averaged 4.4 lbs. This consisted chiefly of Linseed Cake and Egyptian Cotton Cake, but a fair quantity of Crushed Oats and Maize Gluten Feed was also fed.

Herd Q. Nothing very distinctive can be said about this farm. A large variety of foods was fed, the Concentrated Foods consisting of Crushed Oats, Maize Gluten Feed, Distillery Grains, Bombay Cotton Cake, Bean Meal, Decorticated Cotton Cake, Wheat Meal and Cotton Screenings.

Herd O. The Yield of Milk was very high (2.53 gallons), but the Daily Cost of Feeding was also rather high (12.22d.) owing to the large quantities of Cake and Meals being fed. The Cakes and Meals, however, took a cheap form, consisting mainly of Dried Grains. Other foods were Maize Gluten Feed, Maize Germ Meal, and Egyptian Cotton Cake.

Herd AB. This farm is characterized by its Low Cost of Feeding (9.56d. per day). The Yield of Milk, however, is also low (1.97 gallons) so that the two counteract each other. The heaviest allowance of Roots is fed on this farm (77 lbs. per day), but it is satisfactory to find that during the Winter of 1913-14 there was none of the over-indulgence in use of Roots that has been criticized in previous reports.

Herd C. This farm is characterized by its low feeding of Roots (26 lbs. per day) and by the entire absence of Straw. The chief Concentrated Food used is Maize Gluten Feed, other foods fed in smaller quantities being Dried Distillery Grains, Union Cake, and Bombay Cotton Cake.

Herds L and AC. Nothing very characteristic is to be noted about either of these farms. On Farm L the feeding of Cakes and Meals is low (4 lbs. per day), but this is balanced by an allowance of 15 lbs. Wet Grains. On Farm A C a selection has been made at different times from twelve different Concentrated Foods. A fair quantity of Chat Potatoes was fed.

Herd AD. The Yield of Milk was heavy (2.52 gallons), but the Cost of Feeding was correspondingly high (13.57d. per day) ; otherwise this farm would be nearer the top of the table. The high cost of feeding was due chiefly to a heavy allowance of 16½ lbs. Hay, practically no Straw at all being fed. Cabbages formed the main bulk of the "Roots," and the principal Cakes and Meals were Dried Grains, Maize Germ Meal, Maize Gluten Feed and Egyptian Cotton Cake.

Herds P, A, and AE. Nothing calls for particular notice on these farms. A large quantity of Bean Straw was fed on Farm P and some Kohl Rabi on Farm AE.

Causes of High Cost.

Herd AF. The Cost per Gallon of Milk is now getting high (6.11d.). In the case of this farm it is due to heavy feeding of Hay without any Straw, and too liberal an allowance of Cakes and Meals.

Herds M and AG. Both these farms are guilty of extravagant feeding, the Cost of Food per Day being out of proportion to the Yield of Milk. Farm M is feeding more Wet

Grains (24.7 lbs.) and more Cakes and Meals (10.5 lbs.) than any other farm in the Scheme. Farm AG is also feeding too heavily in these respects.

Herd I. This farm has already been mentioned as one on which the ownership changed hands, and the Low Yield of the Cows (1.58 gallons) is due to a misunderstanding about dates of calving between the new owner and the previous one. Taking the figures as they are the feeding allowance is too high.

Jersey Herd. For a herd of Jersey Cows the cost per gallon of milk may be considered to be satisfactory. Jersey Cow Keepers who think that Jersey Cows should never be fed on Roots may be interested to note that these cows received an average allowance of 13 lbs. Cabbages, 9 lbs. Mangels and 8 lbs. Chat Potatoes per day. The Concentrated Food consisted of equal parts of Beans, Bran, Dried Grains and Crushed Oats.

Guernsey Herd. The milk cost nearly 8d. per gallon for food alone, due partly to a low yield of milk (1.60 gallons) and partly to a high cost of feeding (12.57d. per day). An extensive use of Hay (16½ lbs.) without any Straw was chiefly responsible for the high cost of feeding.

It will be seen that as a general rule it is the herds with the best milking cows that produce the cheapest milk. A reference to Table VII. shows this very clearly.

Notes on the Foods Fed.

We come now to the consideration of the various foods employed during the past Winter and their quantities, which are shown in Table VIII. It has been considered advisable to deal with them in four sections.

(*a*) *Root Crops.*

The mainstay of the Dairy Farmer is undoubtedly the Mangel Crop. It will be seen that Mangels (1,925 tons) constitute more than two-thirds of the whole of the Root Crops fed. It is as a rule unwise to feed Mangels before Christmas, and the most popular substitute in the Autumn appears to be Cabbages (650 tons). Only a very small quantity

of Swedes (197 tons), White Turnips (68 tons) and Kohl Rabi (6 tons) were fed on these twenty farms during the last Winter. On farms where Potatoes are grown a share of Chat Potatoes (23 tons) have been given to the cows.

The average allowance of Roots per cow throughout the Winter was 52 lbs. per day and no case of excessive feeding of Roots was discovered such as was found in the first year of the Investigation.

TABLE VIII.

Foods consumed on 20 Farms by 670 Cows in the Winter (November 1st, 1913, to May 1st, 1914).

(*a*) Root Crops.

	£	s.	d.
1,925 tons Mangels at 10/-	962	10	0
650 tons Cabbages at 10/-	325	0	0
197 tons Swedes at 10/-	98	10	0
68 tons Turnips at 8/-	27	4	0
6 tons Kohl Rabi at 10/-	3	0	0
23 tons Potatoes at 20/-	23	0	0
Total 2,869 tons at 10/4	£1,439	4	0
Per Cow, 4.28 tons at 10/4	**£2**	**2**	**11**

(*b*) Fodder Crops.

	£	s.	d.
501 tons Hay at 60/-	1,503	0	0
153 tons Oat Straw at 40/-	306	0	0
21 tons Bean Straw at 40/-	42	0	0
14 tons Pea Straw at 40/-	28	0	0
11 tons Wheat Straw at 25/-	13	15	0
9 tons Barley Straw at 25/-	11	5	0
Total 709 tons at 53/-	£1,904	0	0
Per Cow, 21.16 cwt. at 53/-	**£2**	**16**	**10**

(*c*) Wet Grains.

	£	s.	d.
284 tons at 17/10	253	11	0
Per Cow, 8.48 cwt. at 17/10	**£0**	**7**	**7**

(*d*) Concentrated Foods.

	£	s.	d.
Foods rich in Protein—			
83.9 tons Gluten Feed at 130/-	544	12	6
28.9 tons Linseed Cake at 157/-	227	2	6
21.7 tons Decorticated Cotton Cake at 168/- ..	182	19	0
34.3 tons Egyptian Cotton Cake at 115/-	196	19	0
14.0 tons Bombay Cotton Cake at 97/6	68	7	0
12.0 tons Bean Meal at 144/-	86	11	6
2.2 tons Soya Cake at 168/-	18	9	6
.8 tons Peas at 148/-	5	18	6
.6 tons Gram at 140/-	4	4	0
.8 tons Cocoanut Cake at 165/-	6	12	0
Proprietary Foods—			
8.7 tons Bibby Dairy Cake at 162/-	70	15	6
7.9 tons Union Dairy Cake at 127/-	50	1	6
6.5 tons Shirley Dairy Meal at 144/-	46	17	6
7.5 tons Molbran at 105/-	39	7	6
3.3 tons Union Cotton Cake at 135/-	22	5	6
2.5 tons Silcock's Dairy Cake at 146/-	18	6	6
2.3 tons Mackay's Dairy Cake at 131/-	15	1	0
2.2 tons Bastol at 120/-	13	4	6
1.4 tons Stanley Dairy Cake at 138/-	9	13	0
Foods less Rich in Protein—			
35.8 tons Dried Grains at 109/-	195	9	0
9.4 tons Distillery Grains at 126/-	59	7	0
11.3 tons Bran at 95/-	53	14	0
3.2 tons Straight Run at 145/-	23	6	0
4.5 tons Pollards at 120/-	27	0	0
Starchy and Oily Foods—			
23.4 tons Crushed Oats at 146/-	170	16	6
11.2 tons Maize Germ Meal at 127/-	70	17	6
13.4 tons Barley Meal at 127/-	85	1	6
7.4 tons Wheat Meal at 135/-	50	0	0
7.9 tons Maize Meal at 126/-	49	17	0
5.4 tons Oak Husks at 70/-	18	18	0
3.6 tons Cotton Screenings at 72/-	12	19	0
.8 tons Treacle at 101/-	4	1	0
.7 tons Sugar Pulp at 107/-	3	15	0
Total 379.5 tons at 129/-	£2,452	9	6
Per Cow, 11.33 cwt. at 129/-	**£3**	**13**	**2**

(*b*) *Fodder Crops.*

The chief Fodder Crop for Cows is Hay (495 tons), 70 per cent. of the total Fodder fed being Hay. The most popular substitute is Oat Straw (153 tons), and if the Oats have been cut moderately green this makes a very good substitute. If it does not supply as much nutriment as Hay it at least gives bulk to the ration, and enables the cow to perform the important operation of chewing her cud.

Heavy feeding of Hay is frequently connected with an expensive ration, and where Hay costs as much as 60s. a ton and Oat Straw only 40s. or less, it is as a rule wise to limit the amount of Hay and to replace a fair proportion of it with Straw. The average feeding on these twenty farms was 9½ lbs. Hay per day, and 4 lbs. Straw, and on the six cheapest farms 7¾ lbs. Hay and 5 lbs. Straw. Limited amounts of Bean Straw (21 tons), Pea Straw (14 tons), Wheat Straw (11 tons), and Barley Straw (9 tons) were fed during the Winter.

(*c*) *Wet Grains.*

Only six farms out of the twenty employed Wet Grains, and the average amount fed on these six farms was only 14 lbs. per head per day. Used in moderate quantities Wet Grains are undoubtedly a valuable food, but there is a good deal of prejudice against them. In the first place there is always a lot of wastage in the cartage, and a ton put on rail in London will usually only be about 16 cwt. by the time it is delivered at the farm. Fed in large quantities it may have a deleterious effect on the cows, especially if it is given in heavy allowances close to calving, but at ordinary times up to 30 lbs. a day need not be considered excessive. The quantity should be gradually reduced as the cows get heavy in calf.

(*d*) *Concentrated Foods.*

One of the most important advancements in the recent history of Agriculture has been the development of the Feeding Stuffs Industry, and the list of thirty-three different concentrated foodstuffs that were being fed on these farms gives an idea of the large selection of foods from which the dairy farmer can now make a choice. It used to be thought

that certain individual foods had special powers in making the cows produce milk, but that idea is now almost exploded and the value of any particular food to a dairy farmer is determined almost entirely by its Chemical Composition, its digestibility and its palatability.

Of the foods rich in Protein, Maize Gluten Feed has been by far the most popular food on the farms in the Scheme during the past Winter. At £6 10s. a ton this is the cheapest food in the class and it deserves its popularity. It can be fed either in the dry form or soaked in water. The Cotton Cakes were extensively used, especially Egyptian Cotton Cake, but at £5 15s. per ton this is not such a cheap food as many of the others. Soya Cake seems to have lost its popularity, due probably more to troubles arising from careless feeding than from any fault of its own. When fed in small quantities and similarly to Decorticated Cotton Cake experi ments have shown it to be a very useful food, though at £8 8s. per ton it is expensive. Linseed Cake was at a reasonable price during the winter and was fairly extensively used. Gram is an Indian grain very similar in composition and character to the English Pea, and at £7 per ton is a cheap food. Cocoanut Cake is thought very highly of on the Continent as a food for Dairy Cows.

Of the foods less rich in Protein, Bran at £4 15s. per ton was one of the cheapest. Dried Grains at £5 9s. per ton were very popular, as also were Dried Distillery Grains. Straight Run, which is a mixture of all the offals in the making of Wheat Flour, at £7 5s. per ton is rather expensive.

Coming to the Starchy and Oily Foods, Crushed Oats were extensively used on these farms during 1913-14. Crushed Oats are undoubtedly an excellent food and their value to the cows often appears to exceed what would be expected from their Chemical Analysis, but at the same time it must be pointed out that at £7 6s. per ton they are distinctly expensive. Maize Germ Meal, which contains as much Protein, more Carbohydrates and twice as much Oil, was £1 a ton cheaper. The average analysis of all these foodstuffs is shown in the Appendix.

Oat Husks, Cotton Screenings and Sugar Pulp are three foods which are not very well known. Samples of them

were taken and analysed, and the figures were as follows :—

	Moisture	Oil.	Crude Protein.	Dig. Carbos.	Crude Fibre.	Ash.
Oat Husks ..	7.4	2.7	5.5	53.0	25.5	5.9
Cotton Screenings	8.8	5.4	25.4	29.6	27.8	8.0
Sugar Pulp	8.6	0.9	6.4	66.6	12.9	4.6

" Oat Husks " consist chiefly of the husks of Oats and are probably the waste from some manufacturing process. They contain 25 per cent. of Woody Fibre and require feeding with caution. Cotton Screenings are a waste product in the extraction of cotton seed oil. They too contain a very high percentage of Fibre and should be fed carefully. They are a very much richer food than Oat Husks and are offered at practically the same price. Sugar Pulp consists of the dried pulp of Sugar Beet after extraction of the sugar, and appears to be a good food. It is, however, expensive.

It is not possible to say much about the Proprietary Foods because the materials from which they are made vary from time to time according to the market prices of the different ingredients, but farmers are advised when purchasing not to be guided entirely by the guaranteed analysis. One case was discovered of a Proprietary Cake being fed whose analysis was satisfactory, but on examination it was found that the cake consisted largely of the Sweepings of a Seed Store. In addition to a large quantity of old Clover Seed a large proportion of Weed Seeds were found to be present, and further examination showed that when given the proper conditions of moisture and temperature a great many of these were capable of growth. Such a cake consisting mainly of the seeds of cultivated plants and weeds, many of them unground and alive, was not a suitable one to introduce on to a farm, and farmers should be careful to examine the general character of a Compound Cake before purchasing.

Section B.—Cost during the Summer (1st May to 1st November).

As with the Winter Periods, there are eleven farms which have been in the scheme for two Summers. It is therefore possible to get some idea of the effect of the season on the cost of production of milk by comparing the cost of feeding during the Summer of 1912 with the cost during the Summer of 1913.

In the previous Report a Summer Period of twenty-eight weeks was taken for the year 1912, so that to get a true comparison between the two years it has been necessary to re-calculate the Summer Figures of 1912 on a twenty-six weeks basis, instead of a twenty-eight weeks basis. The Summer Period has therefore been taken to commence on May 1st in both years and to end on October 31st, and the Food Records have been worked out from the weights of foods calculated to have been fed on the middle day of each month.

VALUATION OF THE FOODS CONSUMED.

The value of Foods consumed during the period was estimated under the following heads:—

1.—*Pasture*—calculated from the acreage grazed by the cows and the value or rent per acre; the value was placed higher or lower than the rent according as the quality of the pasture varied above or below the average for the farm.

2. *Aftermath*—valued at 15 per cent. to 20 per cent. of the rent per acre, and calculations based on this figure and the acreage grazed by the cows.

3. *Soiling Crops*—charged to the cows at the estimated cost per acre for cultivations, manure, seed, cutting and carting, rent, rates, etc.

4. *Cakes, Wet Grains, etc.*—calculated from the cost price and the quantities fed to the cows as obtained by the Recorder at each monthly visit.

The attempt made to get at the actual costs in the case of Soiling Crops met with only a limited amount of success.

The cost of an acre of Maize for example was put at £8 18s. on one farm and £5 on another, whilst the cost of growing Tares varied from £5 10s. to £2 6s. per acre. It is possible that such differences actually do exist, but seeing that Root Crops have been valued at the same price on every farm it was thought advisable to charge the same price per acre for Maize, Tares, Trifolium, etc., in the same way, and an average of all the prices suggested for cultivation, manure, seed, cutting and carting, etc., has been taken as the Standard. Only in the valuing of Pasture Land and Aftermath has the cost on the individual farms been taken into account.

COMPARISON OF TWO SUMMERS.

The results calculated for each of the eleven farms that have been in the Scheme for two summers are given in Table IX.

Farms I and M have changed hands; otherwise the two sets of figures are strictly comparable.

A comparison of the averages for all the farms shows that the Yield of Milk per Cow per Day is practically the same in each Summer (2¼ gallons) but that the Cost of Feeding was nearly 1d. a day less in the Summer of 1913. The reason for this is made clear by the following figures, which show that though the proportion of cost for Grass, Soiling Crops and Indoor Feeding was nearly the same in each season, the cost per cow was higher in 1912 in each of the three departments.

COST OF FOOD PER COW FOR THE SIX SUMMER MONTHS.

	1912				1913			
	£	s.	d.		£	s.	d.	
Pasture and Aftermath	1	19	0	(45%)	1	12	8	(45%)
Soiling Crops		6	9	(8%)		3	9	(6%)
Indoor Feeding	2	0	8	(47%)	1	16	1	(49%)
	£4	6	5		£3	12	6	

Evidently over the average of Farms there was a shortage of grass in the Summer of 1912, so that a larger area of Pasture had to be allotted to the cows, more Soiling Crops had to be fed, and more Manger Food became necessary.

TABLE IX.

11 FARMS. SUMMER, 1912; 26 WEEKS (MAY 1ST TO NOVEMBER 1ST).

Herd.	No. of Cows in Milk.	Daily Yield per Cow.	Cost of Food per Cow per day.	Cost of Food per Gallon of Milk.	Percentages of Summer Cost.		
					Pasture and Aftermath.	Soiling Crops.	Indoor Feeding.
		gallons.	pence.	pence.	%	%	%
I ..	27	2.17	2.71	**1.25**	66		34
C ..	31	2.35	3.34	**1.42**	80		20
B ..	40	2.40	3.91	**1.63**	63	3	34
P ..	41	1.96	4.25	**2.17**	43		57
R ..	46	2.31	5.15	**2.23**	55	8	37
K ..	25	2.29	5.13	**2.24**	64	2	34
O ..	24	2.05	4.68	**2.28**	45	19	36
L ..	26	2.25	5.85	**2.60**	78		22
M ..	53	2.39	7.41	**3.10**	29	8	63
Q ..	51	2.46	9.66	**3.92**	28	16	56
A ..	24	2.26	9.12	**4.03**	29	9	62
Average for 388 Cows		2.26	5.52	**2.44**	45	8	47

THE SAME 11 FARMS. SUMMER, 1913; 26 WEEKS (MAY 1ST TO NOVEMBER 1ST).

Herd.	No. of Cows in Milk.	Daily Yield per Cow.	Cost of Food per Cow per day.	Cost of Food per Gallon of Milk.	Percentages of Summer Cost.		
					Pasture and Aftermath.	Soiling Crops.	Indoor Feeding.
		gallons.	pence.	pence.	%	%	%
O ..	23	2.24	2.89	**1.29**	79	4	17
K ..	28	2.35	3.81	**1.62**	61		39
P ..	39	1.85	3.03	**1.64**	73	11	16
C ..	32	2.53	4.58	**1.81**	58		42
I ..	35	2.01	4.01	**2.00**	33		67
B ..	41	2.32	4.89	**2.11**	39	21	40
A ..	23	2.30	4.84	**2.11**	64	15	21
Q ..	50	2.48	5.48	**2.21**	41		59
R ..	48	2.42	5.60	**2.32**	37		63
L ..	25	2.37	5.65	**2.38**	54	5	41
M ..	56	2.07	6.49	**3.13**	24	6	70
Average for 400 Cows		2.27	4.67	**2.06**	45	6	49

A noticeable feature of Table IX. is that though the average run of figures is very similar in the two seasons there is a good deal of difference between the individual farms. Farm I, for example, which heads the list in the Summer of 1912, drops down to fifth place in 1913. This is partly due to a decrease in the milk yield, which has been already explained (page 95), but is mainly due to the Grass giving out in 1913. This is the direct effect of the season. In each year the cows had the run of forty-seven acres of poor Pasture and twenty acres of Aftermath, worth together £36 4s. 6d., but the cost of Manger Food jumped up from £18 7s. 6d. in 1912 to £72 18s. in 1913. Farm A, on the other hand, with the help of an extra twenty-one acres of Aftermath worth £4 manages to save no less than £86 in the cost of Manger Food for 1913, so that the cost per gallon of milk decreases from 4.03d. to 2.11d. Farm Q again spent £206 on Manger Food and £59 on Soiling Crops in the summer of 1912, but in 1913 the fifty cows were allowed an extra twenty-eight acres of Pasture Land, and with a favourable season Soiling Crops were entirely dispensed with, and the cost of Manger Food reduced by £89. Farm P saved £57 in Manger Food by growing an acre of Maize, half an acre of Cabbages, and grazing fifty-five acres of land in 1913, instead of forty-two acres of Pasture and seventeen acres of Aftermath in 1912. These examples show how it is possible by careful management and with suitable climatic conditions to reduce fairly considerably the cost of Summer Feeding.

QUANTITIES OF FOODS FED.

Table X. gives the full details of the quantity and cost of the various foods consumed.

The Cows cost on an average 5.52d. per day to feed in the Summer of 1912 and 4.67d. per day in the Summer of 1913, the cost per gallon of Milk being reduced from 2.44d. in 1912 to 2.06d. in 1913.

It would seem that the usual estimate of an acre to an acre and a half of Grass for a Cow's Summer Grazing is too low. These cows required an acre of Aftermath in addition to one-and-a-third acres of Pasture, but it will be noticed that the rental value of the land is not very high.

TABLE X.

Total Quantities of Food Fed, Summer, 1913.
11 Farms, 26 Weeks (1st May to 1st November).

Grass and Soiling Crops.

	1912—388 Cows.			1913—400 Cows.		
	Area in Acres.	Cost per Acre.	Total Cost.	Area in Acres.	Cost per Acre.	Total Cost.
			£ s. d.			£ s. d.
Pasture ..	562½	24/–	677 19 0	516	22/1	570 3 0
Per Cow ..	*1.4*	*24/–*	*£1 14 11*	*1.3*	*22/1*	*£1 8 6*
Aftermath	415½	3/9	78 17 10	407	4/2	84 18 0
Per Cow ..	*1.1*	*3/9*	*£0 4 1*	*1.0*	*4/2*	*£0 4 2*
Second-cut Seeds ..	24	10/3	12 6 0	20	10/3	10 5 0
Maize	7	126/–	44 0 6	7½	126/–	47 5 0
Tares	2	105/–	10 10 0	3	105/–	15 15 0
Tares and Oats ..	7	105/–	43 1 0			
Rye	2	92/–	9 4 0			
Trifolium	2	46/–	4 12 0	1	46/–	2 6 0
Lucerne	2	65/–	6 10 0			
Total Soiling Crops	46	57/–	130 3 6	31½	48/–	75 11 0
Per Cow ..	*.12*	*57/–*	*£0 6 9*	*.08*	*48/–*	*£0 3 9*

Indoor Feeding.

	Tons.	Cost per Ton.	Total Cost.	Tons.	Cost per Ton.	Total Cost.
			£ s. d.			£ s. d.
Root Crops—						
Mangels	108	10/–	54 0 0	21½	10/–	11 15 0
Cabbages	103	10/–	51 10 0	84	10/–	42 0 0
Swedes	7	10/–	3 10 0			
Turnips	2	8/–	16 0	7½	8/–	3 0 0
Potatoes	1	20/–	1 0 0			
Total	221	10/–	110 16 0	113	10/–	56 15 0
Per Cow ..	*.57*	*10/–*	*£0 5 9*	*.28*	*10/–*	*£0 2 10*
Fodder Crops—						
Hay	4.8	60/–	14 8 0	3.7	60/–	11 2 0
Oat Straw	1.9	40/–	3 16 0	2.1	40/–	4 4 0
Total	6.7	54/4	18 4 0	5.8	52/9	15 6 0
Per Cow ..	*.34 cwt.*	*54/4*	*£0 0 11*	*.29 cwt.*	*52/9*	*£0 0 9*
Wet Grains—	58.7	18/9	54 19 0	93.7	18/3	85 17 0
Per Cow ..	*3.0 cwt.*	*18/9*	*£0 2 10*	*4.7 cwt.*	*18/3*	*£0 4 3*
Concentrated Foods—						
Gluten Feed ..	24.8	122/–	151 13 6	14.8	134/–	99 13 6
gypt. Cotton Cake	19.3	120/–	115 11 6	11.8	121/–	71 5 6
ombay Cotton Cake	6.1	114/–	34 16 0	15.9	103/–	81 17 9

TABLE X. (Contd.).

	1912—388 Cows.					1913—400 Cows.				
	Tons.	Cost per Ton.	Total Cost. £	s.	d.	Tons.	Cost per Ton.	Total Cost. £	s.	d.
Dec. Cotton Cake	9.1	160/-	72	18	0	.7	170/-	7	0	0
Dried Grains	3.4	121/-	20	11	6	2.6	103/-	13	8	3
Bran	3.4	120/-	18	19	6	13.9	102/-	70	13	0
Bean Meal	3.5	160/-	28	0	0	2.0	161/-	16	2	9
Pea Meal	2.1	135/-	13	18	0					
Bastol	6.2	100/-	34	1	6	5.8	107/-	31	1	0
Shirley Cake	3.3	147/-	23	18	0	1.5	150/-	11	5	0
Cow Rations	2.6	160/-	20	16	0					
Soya Treacle Cake ..	2.6	120/-	15	13	0					
Bibby Meal	1.8	145/-	13	1	0	.4	160/-	3	0	0
Bastol Cake	1.9	117/6	11	6	0	3.2	127/6	20	12	6
Mackay's Dairy Cake						1.5	130/-	9	15	0
Silcock's Dairy Cake	.7	160/-	6	0	0	1.9	152/6	13	10	0
Cocoanut Cake ..	.5	160/-	3	17	0					
Union Dairy Cake ..	.8	150/-	6	0	0	.1	140/-		17	6
Homco	1.5	164/6	12	2	6					
Stewart's Cake ..	.1	147/-		19	6					
Linseed Cake						8.3	155/-	64	12	0
Wheat Meal						3.0	158/-	23	14	0
Barley Meal						.6	120/-	3	7	6
Oat Meal						1.6	140/-	11	11	0
Maize Meal						.8	120/-	4	13	0
Soya Meal						.2	155/-	1	13	0
Maize Germ Meal ..						.4	128/-	2	12	6
Molbran						.6	132/6	4	0	0
Total	93.7	128/-	604	2	6	91.6	124/-	566	4	9
Per Cow ..	*4.8 cwt.*	*128/-*	*£1*	*11*	*2*	*4.6 cwt.*	*124/-*	*£1*	*8*	*3*

Results for the Summer 1913.

Coming now to the Summer Feeding of all the farms that were in the Scheme in 1913 the Results are shown in Table XI. (page 121). It will be seen that the Herd at the bottom of the table is producing milk at nearly three times the cost of the Herd that heads the list. It is evidently not a case of poor milk yield in this case, because Herd AE is milking more heavily than Herd O; it can therefore only be a case of extravagant feeding. Herd O consists of twenty-three Cows in milk and had the run during the Summer of forty-six acres of pasture land worth 15s. per acre and twenty-two-and-a-half acres of Aftermath. In addition to this the cows

had four acres of Second-cut Seeds carted to them, 19 cwts. Egyptian Cotton Cake and 6 cwt. Linseed Cake. Herd AE, on the other hand, consisted of the same number of Cows, and these had the run of thirty-three acres of Pasture Land worth £2 per acre and thirty-six acres of Aftermath, and in addition half-an-acre of Maize and more than £73 worth of Manger Food. The Manger Food alone cost more than 4d. per head per day.

CAUSES OF LOW COST OF PRODUCTION.

Taking each farm in turn the following comments may be made:—

Herd O. The run of a large area of Cheap Grass (two acres of Pasture and one acre of Aftermath per cow), which was able to keep the cows in condition with very little assistance, was the chief cause of cheap production (1.29d. per gallon).

Herd K. Here again Cheap Grass appears to be the main cause of cheap milk (1.62d. per gallon). Each cow had the run of an acre of Pasture and two acres of Aftermath for a sum of 35s. per head, and this with the assistance of 23s. worth of Cake and Corn, mostly Maize Gluten Feed and Bran, kept them all through the season.

Herd P. No Aftermath was available for these cows, and they had less than one-and-a-half acres of Pasture (25s. per acre) per head. An acre of Maize, half an acre of Cabbages, and 30 cwts. of Cotton Cake provided the rest of the food for thirty-nine cows.

Herd C. The yield of milk on this farm was particularly good (2.53 gallons) and the feeding was inexpensive (4.58d. per day). Two-and-a-quarter acres of Pasture at 15s. one-and-two-thirds acres Aftermath per head and 5 cwts. of Concentrated Food, chiefly Bombay Cotton Cake and Gluten Feed, completed the Feeding.

Herd I. Indoor Feeding was responsible for more than two-thirds of the cost of feeding. Linseed Cake and Bombay Cotton Cake were the principal foods used.

Herd B. A good deal of Green Soiling is done on this farm. Three acres of Tares, two acres of Maize, one acre of Trifolium, and one acre of Second-cut Seeds provided

Green Food all through the Summer, in addition to which the forty-one Cows grazed twenty-three acres of Pasture (worth 40s. per acre), and forty-two acres of Aftermath, and received £61 worth of concentrated Food.

Herd A. Twenty-six acres of Pasture, fifty-seven acres of Aftermath and two acres of Maize provided green food for twenty-three Cows, in addition to which they received one-and-a-half tons of Bean Meal and three-quarters of a ton of Maize Gluten Feed.

Herd Q. The yield of milk on this farm was good (2.48 gallons) but the feeding was rather expensive (5.48d. per day). During the month of May the cows were receiving nothing but Grass, but from June onwards heavy allowances of Bran, Bombay Cotton Cake, Gluten Feed, Wet Grains and other foods were fed, the total cost of indoor feeding amounting to £117.

Herd AD. No artificial food at all was fed before September, but each cow had the run of one-and-a-half acres of Pasture (worth 28s. per acre) and two acres of Aftermath, and the yield of milk was rather low (2.16 gallons), so that only average figures were obtained.

Herd R. The yield of milk was good (2.42 gallons) but the feeding was expensive (5.60d. per day). The cows had one-and-a-quarter acres of Pasture apiece worth 20s. per acre and one-and-a-quarter acres of Aftermath, and received Manger Food in addition all through the Summer.

Herd L. The yield of Milk was satisfactory (2.37 gallons) but the feeding rather extravagant (5.65d.) In addition to twenty-four acres of Pasture, thirty-six acres of Aftermath and eleven acres of Second-cut Seeds for twenty-five cows, eight-and-a-half tons of Wet Grains were fed and nearly six tons of Egyptian Cotton and other Cakes.

Herd AB. The feeding was rather liberal for the amount of milk given. Egyptian Cotton Cake was fed all through the Summer and the bill for this alone amounted to more than £75.

Causes of High Cost of Production.

Herd AF. The cost of feeding was high (6.65d.), owing to heavy indoor feeding. June was the only month when

no Manger Food was being fed, and from the first week in September onwards the cows were receiving Hay. By the middle of October the cows were practically on their Winter Ration.

Herd AC. The yield of milk on this farm was excellent (2.51 gallons), but the feeding was distinctly expensive (7.55d. per day). The Cows had two acres of Pasture worth 25s. per acre apiece and three-quarters of an acre of Aftermath and were receiving Manger Food throughout the whole of the Summer. The Cows consumed eight-and-a-half cwt. of Cake and Corn apiece during the twenty-six weeks, equivalent to 5 lbs. a day.

Herd M. A low yield of milk (2.07 gallons) was largely responsible for the heavy cost per gallon (3.13d.) in this case, but the cost of feeding was also excessive (6.49d. per day). Grass land was rather deficient, there being less than an acre of Pasture Land and half an acre of Aftermath per head. Seventy tons of Wet Grains were fed and a heavy allowance of Concentrated Food.

Herd AG. The Cows on this farm are usually sold out fat after they have finished milking, so that the feeding is far in excess of the ordinary.

Herd AE. The feeding on this farm has already been criticized. Too much money was expended in trying to get a heavy yield of milk (2.44 gallons).

Guernsey Herd. For a herd of Guernsey Cows the figures are very satisfactory, the cost of production (2.18d. per gallon) being below the average of the seventeen Shorthorn herds. Cheap Grass Land and Economy in Manger Feeding are largely responsible for this.

Jersey Herd. The cost of food per gallon of milk is very high (4.93d.), owing chiefly to a low yield of milk (1.57 gallons) and expensive indoor feeding. The cows had one and one-third acres of Pasture Land apiece, worth £2 an acre, and in addition to this consumed seven cwt. of Cake and Corn during the twenty-six weeks, equivalent to more than four lbs. a day.

A careful study of Table XI. will show that High Cost of Production is very frequently connected with Heavy Indoor Feeding. An examination of the Summer Feeding for

TABLE XI.

Results from 19 Farms. Summer, 1913. 26 Weeks (1st May to 1st November.)

Herd.	No. of Cows in Milk.	Daily Yield per Cow.	Cost of Food per Cow per day.	Cost of Food per Gallon of Milk.	Percentages of Summer Cost.		
					Pasture and Aftermath.	Soiling Crops.	Purchased Foods.
		gallons.	pence.	pence.	%	%	%
O ..	23	2.24	2.89	**1.29**	79	4	17
K ..	28	2.35	3.81	**1.62**	61		39
P ..	39	1.85	3.03	**1.64**	76	7	17
C ..	32	2.53	4.58	**1.81**	58		42
I ..	35	2.00	4.91	**2.00**	33		67
B ..	41	2.32	4.89	**2.11**	39	21	40
A ..	23	2.29	4.84	**2.11**	64	15	21
Q ..	50	2.48	5.48	**2.21**	41		59
AD ..	30	2.16	5.02	**2.32**	71	4	25
R ..	48	2.42	5.60	**2.32**	37		63
L ..	25	2.37	5.65	**2.38**	54	5	41
AB ..	54	2.25	5.44	**2.42**	49		51
AF ..	18	2.32	6.65	**2.87**	47		53
AC ..	20	2.51	7.55	**3.01**	47	3	50
M ..	57	2.07	6.49	**3.13**	24	6	70
AG ..	46	2.52	8.58	**3.40**	21	10	69
AE ..	23	2.44	8.96	**3.67**	50	2	48
Average of 592 Cows		**2.30**	**5.45**	**2.37**	**45**	**5**	**55**
Guernsey	22	1.99	4.35	**2.18**	47		53
Jersey	18	1.57	7.75	**4.93**	46	8	46

1912 will reveal the same thing and the results of the two years are brought together in Table XII., where the farms in the Scheme for the year are grouped together into three divisions, the cheapest milk-producers, the most expensive milk-producers, and the intermediates.

TABLE XII.

Comparison of Summer Costs.

	Daily Yield per Cow.	Cost of Food per Cow per day.	Cost of Food per Gallon of Milk.	Percentages of Cost.		
				Pasture and Aftermath.	Soiling Crops.	Indoor Feeding.
	gallons.	pence.	pence.	%	%	%
20 Farms, Summer, 1912						
7 Cheap Herds ..	2.27	4.15	1.80	51	6	43
7 Intermediate ..	2.17	5.68	2.59	41	6	53
6 Expensive Herds ..	2.23	7.96	3.53	39	6	55
17 Farms, Summer, 1913						
6 Cheap Herds ..	2.21	3.87	1.74	57	6	37
6 Intermediates ..	2.33	5.34	2.29	53	4	43
5 Expensive Herds ..	2.37	7.64	3.21	38	4	58
Average of the above						
13 Cheap Herds ..	**2.24**	**4.01**	**1.77**	**54**	**6**	**40**
13 Intermediates ..	**2.25**	**5.51**	**2.44**	**47**	**5**	**48**
11 Expensive Herds ..	**2.30**	**7.80**	**3.37**	**38**	**5**	**57**

It will be noticed that the Daily Yield of Milk does not bear any very close relation to the variation in the cost of production. If anything, the heavy-milking herds seem to be connected with a heavy cost per gallon. There does, however, appear to be a distinct connection between the cost of production and the cost of Manger Feeding. As the cost of indoor feeding increases (and grazing charges decrease) the cost of milk production increases in proportion. There

seems little doubt that to produce cheap Summer milk a large area of cheap Grass is a very important factor, and that a limited area of Grass combined with heavy indoor feeding is not an economical substitute.

SUMMER REQUIREMENTS OF A COW.

The total quantities of foods fed are shown in Table XIII To take an average of all the figures the Summer Requirements of a single Cow giving two-and-a-quarter gallons milk a day are as follows :—

TABLE XIII.

FOOD CONSUMED ON 19 FARMS BY 633 COWS. SUMMER, 1913 (MAY 1ST TO NOV. 1st).

GRAZING.

	£	s.	d.
779 Acres Pasture at 25/4	987	12	6
677 Acres Aftermath at 4/10	162	18	0

Total—1,456 Acres at 15/9 £1,150 10 6

Per Cow, 2.3 Acres at 15/9 £1 16 4

GREEN CROPS.

20 Acres Second-cut Seeds at 10/3	10	5	0
3½ Acres Sewage Grass at 155/-	27	3	6
9¼ Acres Maize at 126/-	57	0	0
3¾ Acres Tares at 105/-	19	14	0
1 Acre Rye at 92/-	4	12	0
1 Acre Trifolium at 46/-	2	6	0

Total 38½ Acres at 63/- £121 0 6

Per Cow, ·06 Acres at 63/- £0 3 10

INDOOR FEEDING.

ROOT CROPS—

149 Tons Cabbages at 10/-	74	10	0
120 Tons Mangels at 10/-	60	0	0
9 Tons Turnips at 8/-	3	12	0
½ Ton Swedes at 10/-		5	0

Total 278½ tons at 9/11 £138 7 0

Per Cow, 8.8 Cwt. at 9/11 £0 4 4

				£	s.	d.
FODDER CROPS—						
18 Tons Hay at 60/-				54	0	0
5½ Tons Oat Straw at 40/-				11	0	0
½ Ton Wheat Chaff at 25/-					12	6
Total 24 Tons at 54/8 ..	£65	12	6			
Per Cow, ·76 Cwt. at 54/8 ..	**£0**	**2**	**1**			
WET GRAINS—						
114 Tons at 18/-				102	18	8
Per Cow, 3.62 Cwt. at 18/-	**£0**	**3**	**3**			
CONCENTRATED FOODS.						
FOODS RICH IN PROTEIN—						
20.5 Tons Maize Gluten Feed at 134/-				136	15	3
4.7 Tons Dec. Cotton Cake at 166/-				39	2	0
24.8 Tons Bombay Cotton Cake at 104/-				129	4	0
26.1 Tons Egypt. Cotton Cake at 122/-				159	1	6
14.6 Tons Linseed Cake at 157/-				114	13	9
5.8 Tons Bean Meal at 163/-				47	6	3
.5 Tons Gram at 136/-				3	8	0
.5 Tons Peas at 147/6				3	13	9
.2 Tons Soya Meal at 155/-				1	11	0
.3 Tons Mutta at 135/6				1	14	6
FOODS LESS RICH IN PPOTEIN—						
23.5 Tons Bran at 91/6				107	13	6
.8 Tons Straight Run at 125/-				5	6	0
.1 Tons Coarse Pollards at 115/-					11	6
10.3 Tons Dried Grains at 101/-				52	6	0
PROPRIETARY FOODS—						
3.2 Tons Bastol Cake at 128/-				20	12	6
5.8 Tons Bastol at 107/-				31	1	0
3.1 Tons Shirley Dairy Cake at 157/-				24	7	0
1.9 Tons Silcocks Dairy Cake at 142/-				13	10	0
1.2 Tons Bibby Cake at 164/-				9	17	0
2.0 Tons Mackay's Dairy Cake at 140/-				14	0	0
.5 Tons S. B. S. Dairy Cake at 142/-				3	14	0
.1 Tons Union Feeding Cake at 140/-					14	0
.6 Tons Molbran at 132/6				3	19	6
STARCHY AND OILY FOODS—						
3.0 Tons Wheat Meal at 158/-				23	14	0
3.5 Tons Maize Meal at 126/-				22	1	6
2.8 Tons Crushed Oats at 141/-				19	15	6
1.8 Tons Barley Meal at 116/-				10	10	6
.6 Tons Maize Germ Meal at 129/-				3	17	0
Total 161.6 Tons at 124/- ..	£1,004	0	6			
Per Cow, 5.1 Cwt. at 124/- ..	**£1**	**11**	**8**			

The total cost of the cow for twenty-six weeks Summer Feeding is roughly £4, or 3s. 1d. a week, of which £1 16s. or 1s. 5d. per week is for Grazing. The amount of Green Soiling done on these farms is very small, averaging only one square rod per cow. On eight out of the twenty farms no Green Soiling was done at all. On Farm B, where it was carried on to the largest extent, forty-seven square rods were allowed per cow, but on this farm the Pasturage was reduced to half an acre per cow, instead of the average one-and-a-quarter acres, the Aftermath allowed being one acre per cow as above. It is surprising that no Lucerne was fed on any of these farms, but it must be remembered that these farms were not selected as being representative of the area covered; they took a share in the Scheme because the farmers were anxious or willing to do so. The smallest allowance of Grass was on Farm AG, where the Cows had the run of only one-third of an acre of Pasture, worth 42s. per acre, and one-and-a-half acres of Aftermath, but the cost of Indoor Feeding on this Farm, including Green Soiling, amounted to nearly £4 10s. per cow. The lowest cost for Indoor Feeding was on Farm O, where it amounted to less than 9s. per cow, and the Outdoor Feeding was also low, amounting to £1 12s. 6d. per cow. The heaviest cost of feeding per cow was on Farm AE, where the Outdoor Feeding cost £3 8s. per head, and the Indoor Feeding, including Green Soiling, £3 7s. per head. One-and-a-half acres of Pasture and one-and-a-half acres of Aftermath were allowed per head, and this may not be considered excessive, but £3 7s. per head for Indoor Feeding is equivalent to 5d. per day. It is difficult to see how such an outlay in the Summer Time could possibly be profitable.

Comparing the quantities and kinds of foods fed indoors in the Summer with those in use in the Winter Months it is of course natural to find very much less Roots and Fodder being fed. About two-and-a-half times as much Wet Grains were fed per cow in the Winter as in the Summer, and it will be noticed that the price per ton was practically the same for the two periods. Cakes and Meals were selling at about 6s. a ton less in the Summer, and about 3¼ lbs. were fed per head per day as compared with 7 lbs. per head

in the Winter time. The proportion of Starchy and Oily foods fed in the Summer Months is very much less than in the Winter, as is shown by the following Table:—

Table XIV.

Average Summer Requirements of a Cow.

	£	s.	d.	£	s.	d.
Outdoor Feeding.						
1¼ Acres Pasture at 25/-	1	11	0			
1 Acre Aftermath at 5/- ..		5	0			
				1	16	0
Indoor Feeding.						
1 Square Rod Green Crops at 63/- ..		4	0			
9 Cwt. Roots at 10/- per ton ..		4	6			
¾ Cwt. Fodder at 55/- per ton ..		2	0			
3½ Cwt. Wet Grains at 18/- per ton ..		3	0			
5 Cwt. Cakes and Meals at 123/- per ton	1	11	3			
				2	4	9
Total Cost of Summer Feeding (26 weeks) ..				£4	0	9
Cost per day, 5·33d.						

Analysis of the Concentrated Foods Fed to the Cows.

	Winter.	Summer.
Cakes and Meals rich in Protein ..	52 per cent.	61 per cent.
Cakes and Meals less rich in Protein ..	18 per cent.	21 per cent.
Starchy or Oily Foods	19 per cent.	7 per cent.
Proprietary Foods	11 per cent.	11 per cent.
	100	100

More of the "Highly Proteinous Foods" were fed in the Summer than in the Winter, but considerably less of the Starchy and Oily Foods such as home-grown Meals. Maize Gluten Feed is again one of the most popular foods and at 134s. per ton it is still the cheapest of the highly-proteinous foods on the market. Cotton Cake in some form or other was fed on practically every farm, but Bombay Cotton Cake at 104s. per ton is relatively expensive. Gram at £6 16s. per ton is cheap, and better worth the money than Peas at £7 7s. 6d. Mutta is a food imported from India, where it is considered to contain poisonous substances; it should therefore be fed with considerable care.

Of the "Foods less rich in Protein" Bran at £4 11s. 6d. per ton is not only the favourite, but also one of the cheapest foods, whilst of the Starchy and Oily Foods, Maize Meal at £6 6s. per ton and Barley Meal at £5 6s. per ton may be considered good value.

Of the "Proprietary Foods," Bastol at £5 7s. per ton has taken the first place in popularity. If farmers find that in buying Bastol they get value for their money, well and good; but it should be remembered that Bastol consists of Treacle or Molasses (worth up to £5 per ton) soaked up in Sawdust (worth nothing), and although it is claimed that by special treatment the Sawdust is made of some use as a food it is difficult to see how the mixture of the two can possibly be worth the price demanded. Bastol Cake consists of the same material mixed with some other foodstuff rich in Albuminoids, so as to bring up the percentage of Protein, and pressed into cakes. Molbran consists of Molasses soaked up in Bran. Nothing very definite can be said about the composition of the other foods.

Section C.—Cost during the Twelve Months—1st May, 1913, to 1st May, 1914.

As has already been described, the year under review has been divided up into two periods of equal length, the Summer Period of twenty-six weeks (1st May to 31st October), and the Winter Period of twenty-six weeks (1st November to 30th April). By putting the sets of figures for the two periods together it is a simple matter to calculate the Average Daily Yield of Milk and the Cost of Feeding throughout the year.

The results of these calculations are shown in Table XVI. Herd A A which heads the list in Winter Milk Production is excluded because it did not join the Scheme until the Summer Period was nearly over.

Herd O, which has produced Milk at the cheapest food cost during the year, owes its position at the head of the list to its very cheap milk production during the Summer (1.29d. per gallon). During the Winter this Herd was only sixth

TABLE XVI.

RESULTS FROM 19 FARMS.—TWELVE MONTHS (1ST MAY, 1913, TO 1ST MAY, 1914).

Herd.	No. of Cows in Milk.	Daily Yield per Cow.	Cost of Food per Cow per day.	Cost of Food per gall. of Milk.	Analysis of the Cost of Feeding. Outdoor Feeding.			Roots.			Fodder.			Wet Grains.			Cakes and Meals.			Total Cost per Cow.		
		gallons.	pence.	pence.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
O	23	2.39	7.61	**3.19**	1	14	3	1	17	3	2	17	8				4	14	0	**11**	**3**	**2**
C	31	2.32	7.44	**3.21**	2	0	8	1	1	9	2	18	2				5	6	7	**11**	**7**	**2**
K	31	2.26	7.29	**3.23**	1	11	11	1	16	9	2	11	7				4	17	7	**10**	**17**	**10**
B	42	2.26	7.82	**3.46**	2	2	8	2	15	11	2	11	3		16	6	3	11	6	**11**	**17**	**10**
Q	48	2.48	9.37	**3.77**	1	14	9	2	15	9	3	4	2		5	3	6	1	8	**14**	**1**	**7**
P	37	2.04	7.36	**3.60**	2	0	7	2	13	6	3	3	2				3	3	10	**11**	**1**	**1**
R	50	2.27	8.04	**3.54**	1	9	7	2	6	0	2	18	2				5	5	6	**11**	**19**	**3**
A B	55	2.11	7.59	**3.60**	1	18	9	3	13	9	2	7	8				3	11	11	**11**	**12**	**1**
L	27	2.23	8.61	**3.86**	2	5	0	2	3	9	3	14	3	1	7	1	3	9	0	**12**	**19**	**1**
A	23	2.29	8.86	**3.87**	2	17	7	1	15	11	3	5	4				5	10	1	**13**	**8**	**11**
I	32	1.79	7.09	**3.95**	1	2	8	2	8	3	2	2	5				5	5	3	**10**	**18**	**7**
A D	31	2.34	9.35	**3.99**	2	15	11	1	12	7	4	4	9				5	7	7	**14**	**0**	**10**
A C	20	2.46	10.07	**4.10**	2	16	6	2	1	6	3	0	0				7	1	9	**14**	**19**	**9**
A F	20	2.34	10.77	**4.60**	2	3	1	1	11	7	4	12	6				7	9	6	**15**	**16**	**8**
A E	24	2.44	11.47	**4.70**	3	8	9	2	16	5	3	4	4				7	14	11	**17**	**4**	**5**
M	56	2.20	10.49	**4.77**	1	9	11	2	1	2	1	15	4	2	17	10	7	9	3	**15**	**13**	**6**
A G	47	2.41	11.65	**4.84**	1	14	0	3	16	1	3	14	1	1	8	9	6	19	4	**17**	**12**	**3**
Average of 597 Cows		**2.27**	**8.84**	**3.89**	**2**	**0**	**2**	**2**	**8**	**6**	**3**	**0**	**7**		**10**	**11**	**5**	**6**	**4**	**13**	**6**	**6**
Guernsey	21	1.80	7.99	**4.45**	1	7	3	1	3	0	4	0	10				5	3	10	**11**	**14**	**11**
Jersey	18	1.46	8.47	**5.80**	3	5	2	1	13	1	3	7	1				4	12	9	**12**	**18**	**1**

on the list. Herd C. which takes second place, was eighth during the Winter and fourth during the Summer, and it is interesting to notice that Herd K has better figures than Herd C during both periods, and yet is more costly in milk production when the figures for the whole twelve months are taken into consideration. The reason is that Herd K produces most of its milk during the Winter Period, whilst Herd C produces the larger quantity of its milk during the cheap period, the Summer Period. It is therefore hardly fair to compare these farms together, as Herd K has doubtless been getting a higher average price for the milk. Nevertheless, it shows that it is possible for a herd that may be relatively extravagant in milk production during one period of the year to make up for it during the second period. Compare,

for example, Herds P and R. The figures for these two Herds are as follows :—

TABLE XVII.

A Comparison of the Cost of Feeding on Farm P and Farm R.

	Herd P.				Herd R.			
	No. of Cows in Milk.	Daily Yield per Cow.	Cost of Food per Cow per day.	Cost of Food per Gall. of Milk.	No. of Cows in Milk.	Daily Yield per Cow.	Cost of Food per Cow per day.	Cost of Food per Gall. of Milk.
		gallons.	pence.	pence.		gallons.	pence.	pence.
Winter Period	35	2.24	12.17	**5.43**	52	2.13	10.16	**4.77**
Summer Period	39	1.85	3.03	**1.64**	48	2.42	5.60	**2.32**
Twelve Months	37	2.04	7.36	**3.60**	50	2.27	8.04	**3.54**

Herd P is twelfth during the Winter and third during the Summer and finishes up sixth, whilst Herd R is third during the Winter and tenth during the Summer, and finishes up seventh.

Comparison of Two Years.

Compared with the nineteen farms that were in the Scheme in 1912, the Daily Yield of Milk per Cow is higher, the Cost of Food per Cow per Day is lower, and the Cost of Food per Gallon of milk is also lower. The comparative figures are as follows :—

TABLE XVIII.

A Comparison of the Cost of Feeding in 1912 with 1913.

	Jan. 1st, 1912, to Jan. 1st, 1913.	May 1st, 1913 to May 1st, 1914.
Average Number of Cows in Milk ..	680 Cows.	597 Cows.
Average Daily Yield per Cow ..	2.17 galls.	2.27 galls.
Average Cost of Food per Cow per Day	9.37d.	8.84d.
Average Cost of Food per Gallon Milk	**4.32d.**	**3.89d.**

The home-grown foods are calculated at the same costs for each period, but purchased foodstuffs were about 7s. per ton cheaper in the Winter of 1913. This, however, would not affect the Cost per Day by more than .20d., or the Cost per Gallon by more than .08d.

Of the seventeen Shorthorn Herds that were in the Scheme during 1913-14, eleven were in the Scheme during the previous year, but of these two had changed ownership. The following figures show how the results on the nine farms that have been in the Scheme two years compared with the other eight farms which have only been in one year or which have changed ownership :—

TABLE XIX.

A Comparison Between the New Farms in the Scheme and the Old Ones.

	Average No. of Cows in Milk.	Average Daily Yield of Milk.	Average Cost of Food per Cow per day.	Average Cost of Food per gallon of Milk.
Old Farms 1st Year (1912)	322	2.18	9.44	4.32
Old Farms 2nd Year (1913)	312	2.28	8.03	3.52
New Farms 1st Year (1913)	285	2.26	9.77	4.32

It will be seen that, in spite of a slightly larger daily yield of milk, the herds that have been in the Scheme for two years are costing 1.74d. per head per day less for food than the new herds, thus saving 0.80d. on every gallon of milk. They have also produced milk during the twelve months, May 1st, 1913, to May 1st, 1914, at 0.80d. per gallon less for food than they did in the twelve months, January 1st, 1912, to January 1st, 1913. These figures are very significant and show clearly the saving that can be affected from a knowledge of facts and figures. These nine farms with an average between them of 312 cows always in milk sold in 1913 somewhere about 260,000 gallons of milk, so that a saving of 0.80d. per gallon represented to these farms a total saving of roughly £865, or £96 per Herd. If we may take it that the whole of the nineteen farmers who were in the Scheme in 1912

derived as much benefit as these nine then the total saving this year from one year's work (which cost about £180) is £1,824, not a bad return for the money spent.

TABLE XX.

Foods Consumed by 650 Cows in the Year (1st May, 1913 to 1st May, 1914).

	Outdoor Feeding.	£	s.	d.
1,495	Acres Grazing (2.3 Acres per Cow) at 15/9 per Acre	1,180	16	8
39½	Acres Soiling Crops (.06 Acres per Cow) at 63/– per Acre	124	11	8
	Total 1,534½ Acres at 17/– per Acre	1,305	8	4
	Per Cow 2.36 Acres at 17/- per Acre	**£2**	**0**	**2**

	Indoor Feeding.			
Root Crops—		£	s.	d.
2,045	Tons Mangels at 10/– per ton	1,022	10	0
799	Tons Cabbages at 10/– per ton	399	10	0
197½	Tons Swedes at 10/– per ton	98	15	0
77	Tons Turnips at 8/– per ton	30	16	0
6	Tons Kohl Rabi at 10/– per ton	3	0	0
23	Tons Potatoes at 20/– per ton	23	0	0
	Total 3,147½ Tons at 10/1 per ton	1,577	11	0
	Per Cow 4.84 Tons at 10/1 per ton	**£2**	**8**	**6**

Fodder Crops—		£	s.	d.
519	Tons Hay at 60/– per ton	1,557	0	0
158½	Tons Oat Straw at 40/– per ton	317	0	0
21	Tons Bean Straw at 40/– per ton	42	0	0
14	Tons Pea Straw at 40/– per ton	28	0	0
11½	Tons Wheat Straw at 25/– per ton	14	7	6
9	Tons Barley Straw at 25/– per ton	11	5	0
	Total 733 Tons at 53/9 per ton	1,969	12	6
	Per Cow 1.12 Tons at 53/9 per ton	**£3**	**0**	**7**

Wet Grains		£	s.	d.
398	Tons at 17/10 per ton	356	9	8
Per Cow	**.61 Tons at 17/10 per ton .. .. ..**	**£0**	**10**	**11**

Concentrated Foods.

	£	s.	d.
Foods Rich in Protein—			
104.2 Tons Gluten Feed at 131/– per ton	681	8	0
26.4 Tons Dec. Cotton Cake at 168/– per ton ..	222	1	0
60.4 Tons Egypt Cotton Cake at 118/– per ton ..	356	0	0
38.8 Tons Bombay Cotton Cake at 102/– per ton ..	197	11	0
43.5 Tons Linseed Cake at 157/– per ton ..	341	16	0
2.4 Tons Soya Cake at 167/– per ton	20	0	0
17.8 Tons Bean Meal at 150/– per ton	133	18	0
1.3 Tons Pea Meal at 147/– per ton	9	12	0
1.1 Tons Gram at 138/– per ton	7	12	0
.8 Tons Cocoanut Cake at 165/– per ton ..	6	12	0
.3 Tons Mutta at 135/6 per ton	1	14	0
Foods Less Rich in Protein—			
46.1 Tons Dried Grains at 107/– per ton	247	15	0
9.4 Tons Distillery Grains at 126/– per ton ..	59	7	0
34.8 Tons Bran at 93/– per ton	161	7	0
4.0 Tons Straight Run at 143/– per ton	28	12	0
4.6 Tons Coarse Pollards at 120/–	27	11	0
Proprietary Foods—			
9.9 Tons Dairy Bibby Cake at 163/– per ton ..	80	12	0
9.6 Tons Shirley Dairy Meal at 148/–	71	4	0
7.9 Tons Union Dairy Cake at 127/–	50	1	0
8.0 Tons Bastol at 110/–	44	5	0
8.1 Tons Molbran at 107/–	43	7	0
3.2 Ton Bastol Cake at 128/–	20	12	0
4.4 Tons Silcock's Dairy Cake at 145/–	31	16	0
3.4 Tons Union Cotton Cake at 135/–	23	0	0
4.3 Tons Mackay's Dairy Cake at 134/–	29	1	0
1.4 Tons Stanley Dairy Meal at 138/–	9	13	0
.5 Tons S.B.S. Dairy Cake at 142/–	3	14	0
Starchy and Oily Foods—			
26.2 Tons Crushed Oats at 145/–	190	12	0
15.2 Tons Barley Meal at 126/–	95	12	0
11.8 Tons Maize Germ Meal at 127/–	74	15	0
10.4 Tons Wheat Meal at 141/– per ton	73	14	0
11.4 Tons Maize Meal at 126/–	71	18	0
5.4 Tons Oat Husks at 70/–	18	18	0
3.6 Tons Cotton Screenings at 72/–	12	19	0
.8 Tons Treacle at 101/–	4	1	0
.7 Tons Sugar Pulp at 107/–	3	15	0
Total 542.1 Tons at 128/– per ton	3,456	5	0
Per Cow 0.83 Tons at 128/- per ton	**£5**	**6**	**4**

YEAR'S REQUIREMENTS OF A COW.

The total quantities of foods consumed during the twelve months are shown in fuller detail in Table XX. If these farms may be taken as typical of the district then the Average Requirements of a Cow for a year may be taken to be somewhat as follows :—

TABLE XXI.

AVERAGE YEARLY FOOD REQUIREMENTS OF A COW.

	£ s. d.	£ s. d.
1.23 Acres Pasture at 15/9	1 11 2	
1.07 Acres Aftermath at 4/10.. ..	5 2	
.06 Acres Soiling Crops at 63/– ..	3 10	
		2 0 2
4.84 Tons Roots at 10/1 per ton ..	2 8 6	
1.12 Tons Fodder Crops at 53/9 per ton..	3 0 7	
0.61 Tons Wet Grains at 17/10 per ton..	10 11	
0.83 Tons Cakes and Meals at 128/–per ton	5 6 4	
		11 6 4
Total Yearly Cost of Food		**£13 6 6**
Cost per Day £13 6 6 ÷ 365 =		8.77d.

A Cow costs about £4 for the Summer six months and £9 for the Winter six months. The cost per cow on the different farms varied from £10 17s. 10d. to £17 12s. 3d., and the variation per cow in the costs of the different foods was as follows :—

Grass and Soiling Crops	£1 2s. 8d.	to £3 8s. 9d.
Root Crops ..	£1 1s. 9d.	to £3 16s. 1d.
Fodder Crops ..	£1 15s. 4d.	to £3 14s. 1d.
Wet Grains ..	Nil	to £2 17s. 10d.
Cakes and Meals ..	£3 3s. 10d.	to £7 14s. 11d.

The amount of variation is remarkable. It is well-known that some farmers feed considerably more Concentrated Foods than others, but it is surprising to find so much variation in the cost of the Grass and the Home-grown Foods. A careful study of Table XVI. seems to show that a high cost per gallon of milk is more often due to expensive feeding than to poor mikling qualities on the part of the cows. A glance down the column stating the Yield of Milk per Cow shows a

very irregular set of figures, but the last column, the Total Cost of Feeding per Cow, shows a fairly steady increase in the daily cost of feeding to account for the gradually increasing cost per gallon of milk. The connection between the quantity of milk given by the cows and the amount of food they receive (as judged by daily cost) can in many cases be traced very clearly, though there are exceptions. Herd O, for example, averaged 2.38 gallons milk per cow per day, and the cost of feeding each cow for the year was £11 3s. 2d., whilst Herd M, averaging only 2.20 gallons milk per cow per day, was costing £15 13s. 6d. per cow. In other cases, however, Herds B, P, A, A D, I and A E, for example, the connection is clear, but there is a distinct tendency to increase the feeding too much as the yield of milk goes up.

NOTES ON THE FOODS FED.

Table XX. shows the total quantities of food fed to the Cows during the twelve months. Little comment is necessary, as most of the figures were criticized when the Winter Feeding and the Summer Feeding were considered separately. It will be noticed that Mangels constitute two-thirds of all the Root Crops used and that two-thirds of the Fodder is fed in the form of Hay. Of Concentrated Foods, Maize Gluten Feed has been fed in larger quantity than any other, and at £6 10s. per ton it is certainly one of the cheapest foods. More than £400 has been spent on Proprietary Foods. So long as these are wholesome and reasonable in price no objection need be raised, but farmers should see that they are getting fair value for their money, and that they are not paying too much for advertisements. Heavily spiced Cakes and Meals should be viewed with suspicion. Damaged Corn and Mouldy Cakes may be made appetising with a liberal admixture of Aniseed and Fenugreek, but they cannot be made wholesome foods for Stock.

THE AMOUNT OF NUTRIMENT FED IN THE WINTER.

The Economy of Production of the different herds can be calculated from a comparison of the amount of food fed to each herd and the amount of milk yielded from it. In Table XXII. is shown the Chemical Composition of the rations

TABLE XXII.

Composition of the Rations Fed During the Winter.

Herd.	Daily Yield of Milk per Cow.	Cost of Food per Cow per day.	Cost of Food per Gallon of Milk.	Composition of Food fed per Cow per day.		Composition of Food fed per Gall. of Milk.	
				Dig. Protein.	Starch Equiv.	Dig. Protein.	Starch Equiv.
	gallons	pence.	pence.				
A A	2.56	10.79	4.21	1.69	13.05	0.66	5.09
K	2.16	10.21	4.72	1.97	10.49	0.83	4.85
R	2.13	10.16	4.77	1.55	9.12	0.73	4.28
B	2.20	10.58	4.80	1.85	11.88	0.84	5.39
Q	2.49	11.95	4.40	1.84	13.34	0.74	5.36
O	2.53	12.22	4.82	1.95	12.57	0.77	4.96
A B	1.97	9.56	4.85	1.52	10.85	0.77	5.50
C	2.10	10.26	4.88	1.87	9.88	0.89	4.70
L	2.08	10.84	5.20	1.81	12.20	0.87	5.85
A C	2.41	12.65	5.26	1.95	13.57	0.81	5.64
A D	2.52	13.57	5.38	2.42	14.02	0.96	5.56
P	2.24	12.17	5.43	2.11	12.06	0.94	5.38
A	2.28	12.62	5.53	2.14	12.75	0.94	5.59
A E	2.44	13.83	5.67	2.51	14.36	1.03	5.89
A F	2.36	14.45	6.11	2.43	14.42	1.03	6.10
M	2.32	14.64	6.30	2.88	16.38	1.24	7.05
A G	2.29	15.31	6.68	2.82	17.37	1.23	7.58
I	1.58	11.21	7.08	1.95	11.70	1.23	7.39
Average	**2.26**	**12.12**	**5.36**	**2.07**	**12.78**	**0.92**	**5.67**
Guernsey	1.60	12.57	7.87	1.96	12.38	1.23	7.75
Jersey	1.35	9.23	6.84	1.29	9.91	0.96	7.34

fed, and the amount of Digestible Protein and Starch Equivalent fed per cow per day, and per gallon of milk produced, during the Winter of 1913-14. (It is obviously impossible to calculate out the composition of the Summer Feeding seeing that Grass is an unknown quantity.) The Composition of the Rations is calculated out from the average analyses of the foodstuffs fed and only in the case of the Proprietary Foods were special analyses made. It will be noticed that the Cost per Gallon of Milk bears a close connection to the amount of Digestible Protein fed in the ration, and that as the quantity of Digestible Protein increases, the Cost of Food per gallon of Milk rises in proportion. The Protein of a Ration is supplied mainly by the Concentrated Food, and a high Protein Content usually implies a heavy feeding of cake and

corn. A comparison between Tables XX. and VI. will show that this is so, and that the most expensive herds are the ones where the largest quantity of Cake and Corn is being fed.

The Starch Equivalent represents the amount of general nutriment supplied, and it will be seen that a considerably larger quantity of Digestible Food is required to produce a gallon of milk in the case of the Herds at the bottom of the table than in the case of those at the top. The Herds at the top of the table are therefore either more economical milk producers or else those at the bottom of the table are being over-fed.

FOOD REQUIREMENTS OF COWS.

A question which is often asked is "How much Food does a Cow require." It is impossible in this Report to go very far into the scientific side of feeding, but readers are referred to a pamphlet on the subject written by Mr. Mackintosh and published by the college in 1912.

In this pamphlet Mr. Mackintosh suggests the following Standards as being suitable for cows of different weights and supplying varying quantities of milk.

TABLE XXIII.

QUANTITIES OF FOOD CONSTITUENTS RECOMMENDED BY MR. MACKINTOSH FOR COWS UNDER ENGLISH CONDITIONS.

	1,000 lbs. Live Weight.		1,200 lbs. Live Weight.	
	Starch Equiv. lbs.	Containing Protein. lbs.	Starch Equiv. lbs.	Containing Protein. lbs.
For Maintenance (Dry Cow in Calf)	6.0	.70	7.2	.84
For Production (Per Gallon of Milk)	2.5	.50	2.5	.50

As a result of recent scientific work done on this subject by various Investigators at home and abroad, the writer, in addressing a Conference of 250 Dairy Farmers at Wye, in June, 1914, recommended a slight increase in these Standards, especially in the quantity of Digestible Protein that should be fed. The Standards he recommended were as follows :—

TABLE XXIV.

Revised Standards of Food Requirements of Cows.

	1,000 lbs. Live Weight.		1,200 lbs. Live Weight.	
	Starch Equiv. lbs.	Containing Protein. lbs.	Starch Equiv. lbs.	Containing Protein. lbs.
For Maintenance (Dry Cow in Calf)	6.25	.70	7.50	.84
For Production (Per Gallon of Milk)	2.50	.58	2.50	.58

It must be remembered that a cow is fed for two purposes :

(1) To keep her alive and supply the energy for breathing, body temperature, blood circulation, etc. **(The Maintenance Ration)**.

(2) To give milk **(The Production Ration)**.

It is well known that if an animal is not fed it loses in condition and will finally starve. What is described as a Maintenance Ration is a Ration which has been found by experiment to keep a Dry Cow in condition, neither losing weight nor putting on flesh. The larger the cow the more food she requires, so that the Maintenance Ration of a cow varies with the weight of the animal. If the cow is giving milk she requires extra feeding in proportion to the amount of milk she gives and that is known as the Production Ration. The Production Ration is therefore fed in addition to the Maintenance Ration to Cows in Milk. An ordinary allowance of Hay, Straw and Roots will usually supply the requirements of the Maintenance Ration and will form a sufficient allowance for a Dry In-Calf Cow. But if she is giving milk, Cake and Corn must be provided to supply the Production Ration, and the heavier the yield of milk, the more Cake and Corn must be fed. According to the Standards, 2.50 lbs. Starch Equivalent containing 0.58 lbs. Digestible Protein (3 to 4 lbs. Cake and Corn according to Composition) are required for every gallon of milk given, and a Cow giving say four gallons of milk a day will require twice as much Cake and Corn as a Cow giving only two gallons a day. The

principle of feeding all cows alike is unreasonable and indefensible. The low-yielding cows are being over-fed and food is being wasted. The heavy milking cows are being underfed, and are likely to fall off both in yield and condition more quickly where this method is adopted.

The Composition of all the Common Foodstuffs on the Market is given in the Appendix, and knowing the Food Requirements of the Cows and the Composition of the foods, it is merely a simple arithmetic sum to work out the cheapest mixture of foods which will supply the necessary amount of Digestible Protein and Starch Equivalent.

CALCULATION OF THE FEEDING VALUE OF FOODS.

The comparative amounts of Starch Equivalent and Digestible Protein in two foods is a useful guide in estimating their relative Money Values. If, for example, Maize Gluten Feed containing (per lb. of food) 0.21 lbs. Digestible Protein and 0.74 lbs. Starch Equivalent is offered at £6 10s. per ton, and Bombay Cotton Cake containing (per lb. of food) 0.14 lbs. Digestible Protein and 0.37 lbs. Starch Equivalent is offered at £5 10s. per ton, then there is not much doubt that the Gluten Feed is the cheaper food because it contains twice as much Starch Equivalent and one-and-a-half times as much Digestible Protein and is only six-fifths the price. Most Foods of a similar type (*e.g.*, all the foods which have been classified as "Foods rich in Protein") can be roughly compared together by a consideration of their Starch Equivalent only in this way, thus:—

Food.	Starch Equivalent per 100 lbs.	Cost per ton.	Cost per Unit of Starch.
Dec. Cotton Cake ..	71	160/-	160÷71 = 2.25/-
Egypt Cotton Cake ..	40	110/-	110÷40 = 2.75/-
Bean Meal	67	144/-	144÷67 = 2.15/-

Decorticated Cotton Cake at £8 per ton is a cheaper food than Egyptian Cotton Cake at £5 10s. In the same way the foods which have been classified as "Foods less rich in

Protein " can be compared together. The method is exceedingly rough, but it has the advantage of being extremely simple, and though it does not bring into relief, for example, the well-known properties of Linseed Cake for giving " bloom " to an animal, it is in the writer's opinion, when used with judgment, sufficiently accurate for ordinary agricultural purposes.

Some difficulty exists in estimating the Digestible Protein and Starch Equivalent in Proprietary Foods, but knowing the Chemical Composition of the food it is possible to arrive at a sufficiently close estimate of the Starch Equivalent and Digestible Protein contained in it by the method described by Dr. Goodwin in the Board of Agriculture *Journal* for December, 1911.

There are of course many other considerations which have to be borne in mind when compounding a Ration, such as bulk, palatability, effect on the bowels, etc., but this is not the place to deal with these. The old idea that certain individual foods possess some miraculous power of milk production is fortunately dying out, though it still exists in some quarters. Because a certain food is much advertised it does not follow that it is a good milk producer. It more likely follows that, to pay for the cost of the advertising, the farmer is paying a great deal more for it than the food is worth. Cheap milk production depends more on the quantity and proportion of the various foods fed in the ration than on any particular food, and the secret of success is a well-balanced ration, fed in the right quantity according to the milk yield of the cow, and composed of the cheapest foods relative to their composition that the farmer is able to procure.

A Comparison of the Nutriment Actually Fed to the Cows with their Scientific Requirements Suggested.

Table XXV. shows a comparison between the Amount of Nutriment actually Fed to the Cows in the twenty herds and the Scientific Requirements of the Cows as laid down in Mr. Mackintosh's Standards and the writer's New Standards. The comparison shows that ten farms were feeding above Mr. Mackintosh's Standards and ten below, whilst eight farms were feeding above the New Standards and twelve below.

TABLE XXV.

A Comparison of the Scientific Requirements of Cows with the Actual Nutriment Fed.

Herd.	Daily Yield of Milk.	Composition of Ration fed per Cow per Day.		Scientific Requirements. (Mr. Mackintosh's Standards.)		Scientific Requirements. (New Standards.)	
		Dig. Protein.	Starch Equiv.	Dig. Protein.	Starch Equiv.	Dig. Protein.	Starch Equiv.
	galls.	lbs.					
A A	2.56	1.69	13.05	2.09	13.40	2.28	13.70
K	2.16	1.97	10.49	1.89	12.50	2.07	12.80
R	2.13	1.55	9.12	1.89	12.50	2.07	12.80
B	2.20	1.85	11.88	1.94	12.70	2.14	13.10
Q	2.49	1.84	13.34	2.09	13.40	2.28	13.70
O	2.53	1.95	12.57	2.09	13.40	2.28	13.70
A B	1.97	1.52	10.85	1.84	12.20	2.00	12.50
C	2.10	1.87	9.88	1.89	12.50	2.07	12.80
L	2.08	1.81	12.20	1.89	12.50	2.07	12.80
A C	2.41	1.95	13.57	2.04	13.20	2.21	13.70
A D	2.52	2.42	14.02	2.09	13.40	2.28	13.70
P	2.24	2.11	12.06	1.94	12.70	2.14	13.10
A	2.28	2.14	12.75	1.99	12.90	2.14	13.10
A E	2.44	2.51	14.36	2.04	13.20	2.28	13.70
A F	2.36	2.43	14.42	1.99	12.90	2.14	13.10
M	2.32	2.88	16.38	1.99	12.90	2.14	13.10
A G	2.29	2.82	17.37	1.99	12.90	2.14	13.10
I	1.58	1.95	11.70	1.62	11.10	1.71	10.90
Average	**2.26**	**2.07**	**12.78**	**1.96**	**12.80**	**2.14**	**13.10**
Guernsey	1.60	1.96	12.38	1.62	11.10	1.77	11.20
Jersey	1.35	1.29	9.91	1.49	10.40	1.59	10.45

It will be noticed that while the actual feeding is on the average in close agreement with the Scientific Requirements of the cows, there are many individual cases where there is a fairly considerable divergence. The ration fed to Herd A A, for example, was very low in Protein, and that fed to Herds R and A B was deficient in both Protein and Starch Equivalent. Herds A D, A E, A F, and I on the other hand, received a very liberal allowance of Protein, whilst the rations fed to Herds M and A G were high in Starch Equivalent as well.

Where nine herds out of eighteen show such a distinct divergence little value can be attached to an average of the figures, nor would it be reasonable to use the composition of this comparatively small number of rations as a test of the accuracy of any Feeding Standards, especially as no account has been taken of the effect of these rations on the live-weight of the cows. It must be remembered that Scientific Standards are never intended to be followed exactly. They only serve as a guide, and the difference between the two Standards that have been considered is slight and relatively unimportant.

Examples of Scientific Feeding in Actual Practice.

It may be instructive to give a few examples of Rations which were actually being used by farmers in the Scheme during the past winter and which agree very closely with the suggested Standards. It will be seen that the nutriment actually supplied to the cows agreed almost exactly with the Scientific Requirements as laid down by the Agricultural Chemist. Here is one that was fed to Cows giving two gallons of milk :—

Ration Fed to Two-Gallon Cows.

	Dig. Protein.	Starch Equiv.
Scientific Requirements.	lbs.	lbs.
For Maintenance (1,200 lb. Cows) ..	.84	7.50
For Production (Two gallons Milk) ..	1.16	5.00
Total Requirements	**2.00 lbs.**	**12.50 lbs.**

Ration actually fed.	Cost Per Day.	Dig. Protein.	Starch Equiv.
	pence.	lbs.	lbs.
40 lbs. Swedes, 10/- ..	2.14	.20	2.80
10 lbs. Hay, 60/- ..	3.21	.40	3.10
8 lbs. Oat Straw, 40/- ..	1.71	.08	1.52
17 lbs. Wet Grains, 16/- ..	1.45	.68	2.55
2 lbs. Gluten Feed, 131/- ..	1.39	.42	1.48
2 lbs. Egypt Cotton Cake 115/-	1.23	.31	.80
Total	**11.13d.**	**2.09 lbs.**	**12.25**

Cost of Food per Gallon of Milk, 11.13d.÷2=5.56d.

Another ration that was fed to cows giving two-and-a half gallons of milk was as follows :—

RATION FED TO TWO-AND-A-HALF GALLON COWS.

Scientific Requirements.	Dig. Protein.	Starch Equiv.
	lbs.	lbs.
For Maintenance (1,200 lb. Cows)	.84	7.50
For Production (2½ gallons Milk) ..	1.44	6.20
Total Requirements	**2.28 lbs.**	**13.70 lbs.**

Ration actually fed.	Cost Per Day.	Dig. Protein.	Starch Equiv.
	pence.	lbs.	lbs.
56 lbs. Cabbages, 10/-	2.97	.84	5.04
8½ lbs. Hay, 60/-	2.73	.34	2.63
5½ lbs. Oat Straw, 40/-	1.18	.05	1.05
1¾ lbs. Mackay's Cake, 130/- ..	1.22	.28	1.14
1 lb. Dec. Cotton Cake, 165/- ..	.88	.34	.71
1 lb. Mixed Meals, 132/- ..	.70	.13	.75
1¼ lbs. Gluten Feed, 130/- ..	.87	.26	.92
1¾ lbs. Maize Meal, 117/- ..	1.10	.12	1.47
Total	**11.65d.**	**2.36 lbs.**	**13.71 lbs.**

Cost of Food per Gallon of Milk, 11.65d.÷2½=4.66d.

In this case also the nutriment actually supplied to the Cows agreed almost exactly with the Food Requirements as laid down by the Scientific Expert.

If Mr. Mackintosh's figures are taken as the Standard the Decorticated Cotton Cake should be reduced by ½ lb., thus reducing the Cost per Day to 11.21d. and the Cost per Gallon of Milk to 4.48d.

According to Table XXII. the Average Yield of Milk in all the Herds was two-and-a-quarter gallons per day, the Daily Cost of Food per Cow, 12.12d., the Digestible Protein fed, 2.07 lbs., the Starch Equivalent fed, 12.78 lbs., and the Cost of Food per Gallon of Milk, 5.36d. If we take a mean between the above ration for two-and-a-half-gallon Cows and the one before for two-gallon Cows we get the following figures: For Cows giving two-and-a-quarter gallons of Milk, Daily Cost of Food per Cow, 11.39d., Digestible Protein fed, 2.22 lbs., Starch Equivalent fed, 12.98 lbs., Cost of Food per Gallon of Milk, 5.11d. These are therefore cheaper Rations than the average ones fed to the Herds in Table XXII., and yet rations supplying more nutriment. The standard of feeding recommended is in fact slightly higher than the average standard which has been adopted on these farms, but in spite of that, by a careful system of buying, the cost of feeding can be reduced by another ¼d. a gallon in the case of cows giving two-and-a quarter gallons milk.

Another Ration which was being used by one of the farmers in the Scheme to his three-gallon Cows was the following:—

RATION FED TO THREE-GALLON COWS.

Scientific Requirements.	Dig. Protein.	Starch Equiv.
	lbs.	lbs.
For Maintenance (1,200 lb. Cows) ..	.84	7.50
For Production (3 Gallons Milk) ..	1.74	7.40
Total Requirements	**2.58 lbs.**	**14.90 lbs.**

Ration actually fed.	Cost Per Day.	Dig. Protein.	Starch Equiv.
	pence.	lbs.	lbs.
17 lbs. Mangels, 10/– ..	.91	.08	1.19
50 lbs. Cabbages, 10/– ..	2.67	.75	4.50
5 lbs. Hay, 60/–	1.60	.20	1.55
5 lbs. Pea Straw, 40/– ..	1.07	.17	.75
10 lbs. Wet Grains, 24/– ..	1.26	.40	1.50
2 lbs. Gluten Feed, 130/– ..	1.39	.42	1.48
2 lbs. Barley Meal, 130/– ..	1.39	.18	1.48
2 lbs. Wheat Meal, 133/– ..	1.42	.18	1.46
1 lb. Cocoanut Cake, 165/– ..	.88	.17	.78
Total	**12.59d.**	**2.55 lbs.**	**14.69 lbs.**

Cost of Food per Gallon of Milk, 12.59d.÷3=4.20d.

Any of these Rations could easily be adapted to suit the requirements of heavier milking cows. The ration fed to two-and-half gallon cows could, for example, be made suitable for four-gallon cows by doubling the allowance of Decorticated Cotton Cake, Mixed Meals, Gluten Feed and Maize Meal.

The figures would then work out as follows :—

RATION FOR A FOUR-GALLON COW.

Scientific Requirements.	Dig. Protein.	Starch Equiv.
	lbs.	lbs.
For Maintenance (1,200 lbs.)	.84	7.50
For Production (4 gallons)	2.32	10.00
Total Requirements ..	**3.16 lbs.**	**17.50 lbs.**

Ration actually fed.	Cost Per Day.	Dig. Protein.	Starch Equiv.
	pence.	lbs.	lbs.
56 lbs. Mangels, 10/- ..	2.97	.84	5.04
8½ lbs. Hay, 60/-	2.73	.34	2.63
5¼ lbs. Straw, 40/-	1.18	.05	1.05
1¾ lbs. Mackay's Cake, 130/- ..	1.22	.28	1.14
2 lbs. Dec. Cotton Cake, 165/- ..	1.76	.68	1.42
2 lbs. Mixed Meals, 132/- ..	1.40	.26	1.50
2½ lbs. Gluten Feed, 130/- ..	1.75	.52	1.84
3½ lbs. Maize Meal, 117/- ..	2.20	.24	2.94
Total	**15.21d.**	**3.01 lbs.**	**17.56lbs.**

Cost of Food per Gallon of Milk, 15.21÷4=3.80d.

Similarly the above ration could be made suitable for a five-gallon cow by feeding an extra 2 lbs. Mixed Meals and 2½ lbs. Gluten Feed, bringing the Digestible Protein up to 3.79 lbs., the Starch Equivalent to 20.90 lbs. (both above the standard) and the Cost per Gallon of Milk, 3.67d. Or, if it was desired to feed Wet Grains, the ration given for the three-gallon cows could be taken and the Wet Grains, Gluten

Feed, Barley Meal and Wheat Meal doubled in quantity. The figures would then work out as follows :—

RATION FOR A FIVE-GALLON COW.

	Dig. Protein.	Starch Equiv.
Theoretical Requirements.	lbs.	lbs.
For Maintenance (1,200 lbs. Cows) ..	.84	7.50
For Production (5 Gallon Milk) ..	2.90	12.50
Total Requirements	**3.74lbs.**	**20.00 lbs.**

	Cost Per Day.	Dig Protein.	Starch Equiv.
Ration actually fed.	pence.	lbs.	lbs.
17 lbs. Mangels, 10/- ..	.91	.08	1.19
50 lbs. Cabbages, 10/- ..	2.67	.75	4.50
5 lbs. Hay, 60/-	1.60	.20	1.55
5 lbs. Pea Straw, 40/- ..	1.07	.17	.75
20 lbs. Wet Grains, 24/- ..	2.52	.80	3.00
4 lbs. Gluten Feed, 130/- ..	2.80	.84	2.96
4 lbs. Barley Meal, 140/- ..	2.80	.36	2.96
4 lbs. Wheat Meal, 133/- ..	1.42	.36	2.92
1 lb. Cocoanut Cake, 165/- ..	.88	.17	.78
Total	**16.67d.**	**3.73 lbs.**	**20.61 lbs.**

Cost of Food per Gallon Milk, 16.67÷5=3.33d.

According to Mr. Mackintosh's Standards this Ration would be nearly sufficient for a six-gallon Cow.

IMPORTANCE OF HAVING GOOD COWS.

It will be noticed that the cost of food per gallon of milk is much lower for a five-gallon cow than for a two-gallon cow, and the reason is this :—Whether a Cow is a three-gallon Cow or a six-gallon Cow, the Maintenance Ration required to keep her alive, breathing, warm, etc., is the same in both cases, and only the Production Ration varies. An efficient Maintenance Ration for a Dry Cow, consisting of 60 lbs. Mangels, 10 lbs. hay and 10 lbs. straw, will cost roughly about 8d. a day.

A cow giving a gallon of milk will want 3 to 4 lbs. Concentrated Food (Production Ration) in addition to the Maintenance Ration and will cost about 11d. a day. But a cow giving two gallons of milk will not cost double this ; she will only want a few more pounds of Cake and Meal, and will cost perhaps another 2d., *i.e.*, 1s. 1d. per day. Similarly a three-gallon cow might cost 1s. 3d. per day (5d. per gallon) and a four-gallon cow 1s. 5d. a day (4¼d. per gallon.)

The more milk a cow gives the cheaper in proportion becomes her milk, and it is a fundamental truth that if milk is to be produced cheaply good cows are essential. Many experiments have been conducted to show that, provided cows are given a sufficiently liberal diet, the yield of milk cannot be profitably increased to any very large extent by extra feeding. A cow's capacity to milk depends on her power of secreting milk from her blood, and that is not a matter of feeding, but of breeding and of the individuality of the cow. No amount of liberal feeding or of skilful feeding will make a bad milker into a good one. Good milkers have got to be produced by breeding from the best, and then, and not until then, can the farmer hope to produce cheap milk.

Necessity of Keeping Milk Records.

It is often stated that the Cowman knows well enough which are the best milkers in the herd without weighing the milk, but experience shows that this is not the case. The cows which the cowman thinks the best are, as a rule, the five and six-gallon cows which fill the bucket. But they usually only keep it up for a short time. A four-gallon cow which can keep up her supply of milk is better than a five-gallon cow who within a few weeks is down to three or two-and-a-half gallons, and when the figures are added up at the end of the year the record for the four-gallon cow will prove to be very much better than the record for the five-gallon cow. But the cowman does not notice her. It is doubtful if a cowman can tell to within 100 gallons how much milk a cow actually gives in the year.

The Milk Dial is the only reliable test. The milk should be weighed at least one day a week and the figures totalled up from week to week until the year is complete. Thus the

good cows and the bad cows manifest themselves and at the same time information is obtained for feeding the cows in the only rational manner—according to their actual yield of milk. The daily amount of milk each cow is giving should be marked up from time to time on the wall in front of her, and the quantity of concentrated food fed regulated by that amount. Milk Records and Food Records thus go hand in hand and one is a necessary complement to the other.

A saving of even a half-penny per gallon in the cost of feeding works out in the case of a single 600-gallon cow to a reduction of £1 5s. per annum in the Food Bill, or in the case of a herd of thirty cows, to a reduction of £37 10s. per annum. Experience shows that in many cases a reduction of considerably more than a half-penny per gallon in the cost of feeding can be made, so that the slight increase in labour involved by the regular weighing of the food and of the milk is very handsomely repaid by the results.

PART II.

THE MILK RECORDS.

PART II.

THE MILK RECORDS.

Space prohibits the publishing of the individual Records of each cow as was done in the last Report, and it is only possible to give a summary for each Herd. Only sixteen Herds are included in the Tables. Herd I (thirty cows) has been left out for the reason already stated. Herd A A (twenty-five cows) has been excluded because it was only in the scheme during a part of the year, and the Jersey (eighteen cows) and Guernsey herds (twenty-one cows) have been omitted because they cannot fairly be compared with the others. There were roughly 600 cows in the Scheme throughout the whole of the twelve months, but the number of cows which contributed to the figures in the first part of this Report was probably over 1,000.

Table XXVI. shows the composition of the different herds, this being an important factor in considering the average milk yield of each herd and the cost of feeding. It will be observed, for example, that Herd B is a herd of young cows, which cannot therefore be expected to give such a heavy average yield of milk as Herd Q, where the cows are of all ages.

Table XXVII. classifies the cows in each herd according to the amount of milk they gave. It will be noticed that 600 gallon Cows are the commonest (25 per cent. of this whole) though there are also a very large number of 500 gallon cows (21 per cent.) and 700 gallon cows (19 per cent.). Cows giving from 500 to 800 gallons of milk constitute 65 per cent. of the whole of the cows in the scheme. The two extremes were a third-calf cow giving 1,238 gallons of milk in forty-nine weeks in Herd B, and a fourth-calf cow giving 279 gallons of milk in thirty-six weeks in Herd P. It has been shown

TABLE XXVI.

THE COMPOSITION OF THE VARIOUS HERDS.

Herd.	Total cows complet-ing the year.	1st Calf Cows.	2nd Calf Cows.	3rd Calf Cows.	4th Calf Cows.	5th Calf Cows.	6th Calf Cows.	7th Calf Cows.	8th Calf Cows.	Doubtful age.
A E	23	1	4	1	4	0	2	3	2	6
A	19	0	3	2	2	5	2	1	1	3
B	40	6	10	13	5	3	0	0	0	3
C	35	3	3	5	7	6	5	1	3	2
M	52	7	8	8	11	8	9	1	0	0
AD	26	1	4	11	6	2	0	0	0	2
K	26	0	5	6	4	4	1	1	1	4
L	21	2	6	8	0	0	2	0	0	3
O	21	0	3	5	3	8	1	0	1	0
P	37	2	7	4	8	3	1	4	1	7
Q	45	5	5	7	6	4	9	4	5	0
A G	42	0	0	4	7	6	5	2	4	14
R	51	0	2	8	8	6	6	3	3	15
A F	18	1	3	3	5	2	2	0	2	0
S	18	6	5	5	0	1	0	0	1	0
A B	47	3	5	8	9	9	3	4	0	6
Totals	**521**	**37**	**73**	**98**	**85**	**67**	**48**	**24**	**24**	**65**
Percentage of the Herd		**7**	**14**	**18**	**16**	**13**	**9**	**5**	**5**	**13**

that an average cow costs about £13 a year (5s. a week) for food alone so that if we allow 8d. a gallon as an all-round price for the milk cows giving less than 400 gallons in a year are not even paying for their keep. Two per cent. of the cows with completed records gave less than this amount of milk.

TABLE XXVII.

Milking Capacities of the Various Herds.

Herd.	No. of Cows giving complete record.	No. of Cows giving in Gallons of Milk. 400 or less.	401 to 500	501 to 600	601 to 700	701 to 800	801 to 900	901 to 1,000	Over 1,000	Average No. of Weeks in Milk.	Average Yield of Milk.	Value at 8d. Per Gall. of each cow's milk. £	s.	d.
Q	45	–	2	4	9	9	10	9	2	43	756	25	4	0
S	18	–	1	3	3	3	3	4	1	40	740	24	13	4
O	21	–	–	4	6	7	2	1	1	42	706	23	11	0
K	26	–	2	5	4	8	5	0	2	42	706	23	11	0
C	35	–	4	4	10	4	6	7	–	42	705	23	10	4
A E	23	–	2	3	5	5	6	2	–	39	704	23	9	8
A D	26	1	1	6	7	3	2	5	1	43	702	23	8	4
B	40	–	1	10	11	8	5	2	3	43	692	23	1	4
A	19	1	1	4	4	4	3	1	1	41	688	22	18	8
A G	42	–	3	10	7	12	5	4	1	41	684	22	16	0
R	51	–	3	8	16	14	5	5	–	41	679	22	12	8
L	21	–	–	5	9	4	3	–	–	41	656	21	17	4
A B	47	2	5	13	9	7	5	4	2	43	642	21	8	0
A F	18	2	3	2	4	2	3	2	–	40	629	20	19	4
M	52	1	5	18	15	8	3	2	—	40	604	20	2	8
P	37	3	5	9	13	3	3	1	–	43	604	20	2	8
Total	521	10	38	108	132	101	69	49	14	41	681	22	14	0
Per cent.		2	7	21	25	19	13	9	3					

The average yield of milk over the whole of the Herds is 681 gallons, a figure which would probably be considered too high as an average of all the herds in the South Eastern Counties. The best herd average was 756 gallons, the total number of cows in the herd being forty-three, and the worst

herd average 604 gallons in another herd of forty-three cows. During the year 25 per cent. of the cows gave over 800 gallons, 65 per cent. between 500 and 800, and 9 per cent. 500 gallons or less.

The difference in the value of the milk between the best and the worst cows in each herd is shown in Table XXVIII. The highest yield of any cow reckoned at 8d. per gallon was worth £41 5s. 4d. and the lowest monetary return was £9 6s., a difference of £31 19s. 4d. in the gross returns from the two cows. This table shows, perhaps better than any other,

TABLE XXVIII.

Herd.	No. of Cows giving complete records.	Yield of Milk from Individual Cows.			Value of Milk at 8d. Per Gall.			Difference in Value of Milk between Best and Worst.		
		Highest in Herd.	No. of Weeks in Milk.	Lowest in Herd.	£	s.	d.	£	s.	d.
Q	45	1162	42		38	14	8			
			34	463	15	8	8	23	6	0
S	18	1122	42		37	8	0			
			37	451	15	0	8	22	7	4
O	21	1120	48		37	6	8			
			45	506	16	17	4	20	9	4
K	26	1057	40		35	4	8			
			46	426	14	4	0	21	0	8
C	35	980	41		32	13	4			
			36	396	13	4	0	19	9	4
A E	23	958	39		31	18	8			
			35	423	14	2	0	17	16	8
A D	26	1052	41		35	1	4			
			35	381	12	14	0	12	7	4
B	40	1238	49		41	5	4			
			38	468	15	12	0	25	13	4
A	19	1082	51		36	1	4			
			30	378	12	12	0	23	9	4
A G	42	1091	41		36	7	4			
			36	391	13	0	8	23	6	8
R	51	985	49		32	16	8			
			36	445	14	16	8	18	0	0
L	21	835	47		27	16	8			
			37	489	16	6	0	11	0	8
A B	47	1086	49		36	4	0			
			31	314	10	9	4	25	14	8
A F	18	970	43		32	6	8			
			35	297	9	18	0	22	8	8
M	52	875	47		29	3	4			
			49	353	11	15	4	17	8	0
P	37	939	49		31	6	0			
			36	279	9	6	0	22	0	0

the importance of having good cows. The cost of feeding a 600 gallon cow is only slightly greater than a 500 gallon cow, and labour and other charges are the same in each case so that the total difference in cost is not at all proportionate to the greater value of the produce from the heavy milkers.

The cost of feeding the 600 gallon cow for the year should be about £1 5s. more than for the 500 gallon cow, whereas at 8d. per gallon the milk would be worth an additional £3 6s. 8d. For every extra 100 gallons of milk obtained there would be a further surplus in revenue of £3 6s. 8d. over additional expenditure in food. But the only possible way to rear a herd of heavy milkers is by breeding from those cows which, as the result of the keeping of accurate Milk Records, are found to have the greatest milk-producing capacity.

APPENDIX.

DATA FOR CALCULATING SUITABLE FEEDING RATIONS FOR DAIRY COWS AND THE COST OF FEEDING.

APPENDIX.

Food Requirements of Cows.

(*a*) Maintenance Ration—to maintain the condition of the animal (For a Dry In-calf Cow).

	Dig. Protein. lbs.	Starch Equiv. lbs.
Cows weighing 1,000 lbs. require	.70	6.25
,, 1,200 lbs. ,, ...	.84	7.50
,, 1,400 lbs. ,, ...	.98	8.75

N.B.—The weight of an average Shorthorn Cow may be taken as roughly 1,200 lbs.

Where it is desired to *improve* the condition of the Cow whilst dry, a diet rather more liberal in Starch Equivalent than the above is recommended.

(*b*) Production Ration—to be fed in addition to the Maintenance Ration to a Cow in Milk.

	Dig. Protein. lbs.	Starch Equiv. lbs.
Cows giving 1 gallon Milk per day require	.58	2.50
,, 1½ ,, ,,	.87	3.70
,, 2 ,, ,,	1.16	5.00
,, 2¼ ,, ,,	1.30	5.60
,, 2½ ,, ,,	1.44	6.20
,, 2¾ ,, ,,	1.58	6.80
,, 3 ,, ,,	1.74	7.50
,, 3½ ,, ,,	2.03	8.70
,, 4 ,, ,,	2.32	10.00
,, 4½ ,, ,,	2.61	11.20
,, 5 ,, ,,	2.90	12.50
,, 6 ,, ,,	3.48	15.00

Average Composition per lb. of Common Feeding Stuffs.

	Dig. Protein.	Starch Equiv.		Dig. Protein.	Starch Equiv.
Soya Cake ..	.34	.67	Barley	.07	.74
Dec. Cotton Cake	.34	.71	Oats	.09	.63
Egyptian Cotton Cake	.15	.40	Maize	.07	.84
Bombay Cotton Cake	.14	.37	Beans	.19	.67
Linseed Cake ..	.25	.76	Peas	.17	.70
Earthnut Cake ..	.40	.79	Barley Straw ..	.005	.18
Cocoanut Cake ..	.17	.78	Wheat Straw ..	.002	.12
Wheat Middlings (fine)	.12	.74	Oat Straw ..	.01	.19
Wheat, Sharps (coarse)	.11	.58	Bean Straw ..	.03	.19
Bran	.10	.47	Pea Straw ..	.03	.15
Maize Germ Meal	.10	.78	Meadow Hay ..	.04	.31
Gluten Feed ..	.21	.74	Clover Hay ..	.05	.31
Rice Meal ..	.06	.70	Cabbage and Rape	.01	.09
Malt Combs ..	.11	.40	Turnips ..	.005	.06
Wet Grains ..	.03	.15	Swedes ..	.005	.07
Dried Grains ..	.12	.51	Mangels ..	.005	.07
Treacle and Molasses	Nil.	.48	Carrots ..	.005	.09
Wheat	.09	.73	Potatoes ..	.005	.19

FOODSTUFFS.

COST PER TON CONVERTED INTO COST PER LB.

Per ton.	Per lb. pence.	Per ton.	Per lb. pence.	Per ton.	Per lb. pence.
8/-	.043	87/6	.468	130/-	.70
10/-	.053	92/6	.49	132/6	.71
13/-	.069	95/-	.51	135/-	.72
16/-	.086	97/6	.52	140/-	.75
17/-	.091	100/-	.53	145/-	.78
18/-	.096	102/-	.55	147/6	.97
19/-	.102	105/-	.56	150/-	.80
20/-	.107	107/6	.58	152/6	.82
22/6	.120	110/-	.59	155/-	.83
23/6	.126	112/6	.60	157/6	.84
30/-	.160	115/-	.62	160/-	.85
40/-	.214	117/6	.63	162/6	.87
50/-	.268	120/-	.64	165/-	.88
60/-	.321	122/-	.65	170/-	.91
70/-	.375	123/-	.66	173/6	.93
75/-	.401	125/-	.67	177/-	.95
80/-	.428	127/6	.68	195/-	1.04

The average value placed by farmers in Kent and Surrey on Hay, Straw, White Turnips, Swedes, Mangels, Cabbages and Potatoes is as follows :—

	Per ton.		Per ton.
Meadow Hay ..	60/-	Swedes and Mangels..	10/-
Oat Straw	40/-	Cabbages	10/-
White Turnips ..	8/-	Potatoes	20/-

EXAMPLE.

An average-sized Shorthorn Cow is giving two-and-three-quarters gallons milk per day.

Food Requirements :	Dig Protein. lbs.	Starch Equiv. lbs.
Maintenance Ration (Cow weighs 1,200 lbs.)	.84	7.50
Production Ration ($2\frac{3}{4}$ Gallons Milk) ..	1.58	6.80
Total Requirement ..	2.42	14.30

Ration :	Cost per Day. pence.	Dig. Protein. lbs.	Starch Equiv. lbs.
50 lbs. Mangels, 10/-	2.65	.25	3.50
10 lbs. Hay, 60/-	3.21	.40	3.00
8 lbs. Oat Straw, 40/-	1.71	.08	1.52
20 lbs. Wet Grains, 20/-	2.14	.60	3.00
3 lbs. Maize Gluten Feed, 120/- ..	1.92	.63	2.22
2 lbs. Egypt. Cotton Cake, 110/- ..	1.18	.30	.80
$1\frac{1}{2}$ lbs. Bran, 100/-	.79	.15	.70
Total	13.60	2.41	14.74

Cost of Food per Gallon of Milk, 13.60d.÷$2\frac{3}{4}$=4.94d.

WYE COLLEGE MILK INVESTIGATION.

Sixth visit to Mr. Brown's Farm. *Date, March 6th.*

No. of Cows in Milk 28.

Day's Yield of Milk: Morning, 27½ Gallons; Evening, 36 Gallons. Total, 63½ Gallons.

Average Yield per Cow: 651 lbs. Milk, ÷ 28 Cows = 23.25 lbs. Milk.

Amount, Cost, and Composition of Ration.

	Price per Ton.	Cost per Day.	Dig. Protein.	Starch Equiv.
		pence.	lbs.	lbs.
60 lbs. Mangels	10/-	3.18	.30	4.20
10 lbs. Meadow Hay.. ..	60/-	3.21	.40	3.10
10 lbs. Oat Straw	40/-	2.14	.10	1.90
2 lbs. Dec. Cotton Cake ..	162/6	1.74	.68	1.42
3 lbs. Maize Gluten Feed ..	130/-	2.10	.63	2.22
1½ lbs. Maize Germ Meal ..	130/-	1.05	.15	1.17
1½ lbs. Bran	100/-	.79	.15	.70
Totals		14.21	2.41	14.71

Scientific Requirements.	Dig. Protein.	Starch Equiv.
	lbs.	lbs.
Maintenance Ration (1,200 lb. Cows) ..	.84	7.50
Production Ration (2.3 Galls. Milk) ..	1.30	5.75
Totals	2.14	13.25

		Average of all Farms last month.
Average Daily Yield of Milk per Cow ..	23.25 lbs.	22.40 lbs.
Average Daily Cost of Ration ..	14.21 pence	14.88 pence
Average Cost of Food per Gallon Milk ..	6.11 ,,	6.58 ,,
Composition of Milk—Morning ..	3.2 % Fat	3.3 % Fat
,, ,, Evening ..	3.6 % Fat	3.8 % Fat

REMARKS:—The feeding is in excess of the Scientific Requirements of the Cows, and could probably be reduced without any falling off in the Milk Yield.

(Signed)

SOME RESULTS FROM THE FATTENING OF DAIRY COWS.

By C. Hutchinson, B.Sc. (Agric.).

In any regular system of dairy farming, a draft of cows deemed unsuitable for further breeding will frequently be necessary. The most profitable method of disposing of such cows is a matter of considerable economic importance. The peculiar conditions prevailing on each farm, and the system of dairy-farming practised, will generally determine the state of the draft cows when put on the market. Where the prevailing system of management is to purchase in-calving or newly calven cows, to refuse them service, and to secure a maximum yield of milk in a minimum of time by feeding excessively large quantities of concentrated foods, the cows are maintained in high condition, and are disposed of directly to the butcher when their yield of milk reaches an unprofitable level. This system is in vogue most commonly in the neighbourhood of large towns. On the more usual type of dairy farm the cows are kept in a natural breeding condition, and the drafts are marketed in the store state, or are sold for slaughter after a period of fattening.

Barren store cows are invariably sold at a low price, and necessarily so to allow any margin of profit to the feeder. The advisability of adopting the town dairyman's method in respect of barren cows is a point to which the cowkeeper's attention might profitably be directed.

The farmer usually knows the particular animals to be drafted out of his herd as barren cows, while their milk yield is still a profitable quantity. The general practice amongst farmers is to increase the feed of such cows so that they reach a half fat condition by the time they are dried off, and then by a further improvement in feeding to bring them to the block in a comparatively short time. Little attempt appears to

have been made to obtain an approximate determination of the milk yield of the cow when an addition to an already sufficient "Milk Production Ration" should be made, or when this in turn should be superseded by a heavier "Fattening Ration." To obtain some information on these matters, five cows described below were utilized, and the cost of food and returns at different stages of the fattening process are calculated.

TABLE I.

Cow.	Age.	Weeks in Milk to October 24th, 1912.	Daily yield of Milk, October 24th, 1912.	Live Weight of Cow, October 24th, 1912.		
				cwts.	qrs.	lbs.
No. 1	9 years	10	13 lbs.	11	0	13
No. 2	8 ,,	30	17 ,,	8	3	15
No. 3	10 ,,	24	20 ,,	11	0	27
No. 4	$3\frac{1}{2}$,,	30	11 ,,	9	1	17
No. 5	$3\frac{1}{2}$,,	37	16 ,,	9	1	15

The cows were of Shorthorn breeding, in healthy milking condition, and typical of the drafts which occurred year by year in a herd of twenty-five cows.

So long as the cows were on the rations of the transition period between summer and winter feeding, the returns in milk were above the paying limit, but with the introduction of the more costly winter rations, the cost of food would barely be repaid by the value of the milk produced.

The Maintenance Ration was allowed each cow according to her size, and as an average for the five cows, the daily allowance of food and the cost thereof were as follows :—

TABLE II.

Food per Cow per Day.	Cost or Estimated Value.	Cost per Cow per Week.	
		s.	d.
40 lbs. Swedes or Mangolds..	6/8 per ton		10
7 lbs. Meadow Hay ..	£3 ,, ,,	1	$3\frac{3}{4}$
14 lbs. Oat Straw ..	£2 ,, ,,	1	9
2 lbs. Egyptian Cotton Cake	£6 ,, ,,		9
1 lb. Molascuit ..	£5 ,, ,,		$3\frac{3}{4}$
		Total 4	$11\frac{1}{2}$

The value of home-grown foods is taken at a figure in close accordance with the values usually assigned to the respective products by dairy farmers in the South East of England.

This winter ration is somewhat in excess of the theoretical maintenance requirements, and on it dry cows recover condition for their next calving.

As a "Milk Production Ration," each cow received four lbs. of the following mixture daily for each gallon of milk she produced.

1 part of Egyptian Cotton Cake.
1 ,, ,, Crushed Oats, valued at £6 per ton.
1 ,, ,, Gluten Feed, valued at £7 per ton.
1 ,, ,, Bran, valued at £5 per ton.
Four pounds of this mixture cost 2¼d.

This system of feeding allows a liberal sufficiency of nutrients for all requirements and was continued for eight weeks, October 24th to December 19th. The cows were daily allowed a few hour's exercise on a bare pasture.

Throughout the second period of eight weeks, *i.e.*, December 19th to February 13th, the cows were confined to stalls and to the rations previously allowed an addition of six pounds per animal per day of the following mixture was made.

1 part Egyptian Cotton Cake.
2 parts Linseed Cake, valued at £9 10s. per ton.
1 part Dried Grains, valued at £6 5s. per ton.
1 part Gluten Feed.
The cost of this added "Fattening Ration" is approximately 2s. 10½d. per cow per week.

During the third period, *i.e.*, from February 13th onwards, the "Milk Production Ration" was discontinued, and an addition to the six pounds "Fattening Ration" was made in the form of four pounds per day of Para Rubber Seed Cake. This cake is not quoted on the market, but its composition and the results of feeding trials conducted on a limited scale, suggest a value of about £8 per ton. From the commencement of this third period, the cows were dried off as quickly as

possible, and were sold when they were considered sufficiently fat to realize the highest rate for cows of their class.

When the financial side of the three periods is considered, a first difficulty is experienced in fixing an average value to the increase in carcase weight as the animal advances from the "store" to the "fat" condition, and this difficulty is much increased when an attempt is made to discriminate between the values of the carcase increases made at successive stages of the fattening process. To arrive at an average value of this carcase increase, the five barren cows which at the end of October were no longer profitable as dairy stock, were valued at the current market rates for such animals, and this was in the neighbourhood of 28s. per cwt.

The difference between the valuation of the cows on October 24th, and the sum ultimately obtained for the cows in the Auction Mart is divided by their total increase in weight, and this sum is taken as the value of carcase increase assumed uniform throughout the fattening process. In reality the value somewhat increases as fattening advances.

The calculation of the value of live weight increase is as follows:

	cwts.	qr.	lbs.
Total weight of 5 cows when sold ..	58	1	12
,, ,, ,, ,, October 24th ..	50	0	3
Gain in weight ..	8	1	9

	£	s.	d.
Sale price of 5 cows in March and April	87	5	0
Valuation of 5 cows at 28s. per cwt, on October 24th	70	0	9
Increase in value ..	£17	4	3

Value per cwt. live weight increase .. £2 1s. 3d.
or, Value per lb. live weight increase 4$\frac{3}{7}$d. approximately.

Results of the feeding in the first period, the cows receiving a liberal "Maintenance Ration" and a sufficient "Milk Production Ration."

	Cow No. 1. cwts. qrs. lbs.	Cow No. 2 cwts. qrs. lbs.	Cow No. 3. cwts. qrs. lbs.	Cow No. 4. cwts. qrs. lbs.	Cow No. 5. cwts. qrs. lbs.	Total. cwts. qrs. lbs.
Live weight, Oct. 24th	11 0 13	8 3 15	11 0 27	9 1 17	9 1 15	50 0 3
" " Dec. 19th	11 1 12	9 0 7	11 2 12	9 1 14	9 2 24	51 0 13
" " increase in 8 wks.	27	20	41	—3	37	122
Milk yield in 8 wks.	746	814	882	616	794	3,852

	£	s.	d.
Cost of Maintenance Ration—5 cows, 8 weeks at 4s. $11\frac{1}{2}$d. per cow, per week	9	18	4
Cost of Milk Production Ration for 3852 lbs. at $2\frac{1}{7}$d. per gallon	4	2	6
Total cost of Food ..	£14	0	10
Value of 122 lbs. live weight increase at $4\frac{3}{7}$d. per lb.	2	5	0
Value of 3,852 lbs. Milk at 8d. per Imperial gallon	12	16	$9\frac{1}{2}$
Total Returns ..	£15	1	$9\frac{1}{2}$
Excess of Returns over Cost of Food ..	£1	0	$11\frac{1}{2}$

Result of feeding in the second period, the cows receiving a liberal "Maintenance Ration," a sufficient "Milk Production Ration" and a moderate "Fattening Ration."

	Cow No. 1.			Cow No 2.			Cow No. 3.			Cow No. 4.			Cow No. 5.			Total.		
	cwts.	qrs.	lbs.	cwts.	qrs	lbs.	cwts.	qrs.	lbs.	cwts.	qrs.	lbs	cwts.	qrs.	lbs	cwts.	qrs.	lbs.
Live weight, Dec. 19th	11	1	12	9	0	7	11	2	12	9	1	14	9	2	24	51	0	13
,, ,, Feb 13th	12	1	1	9	2	17	12	1	7	10	2	0	10	1	22	55	0	19
,, ,, increase in 8 wks.			101			66			79			126			82			454
Milk yield in 8 wks.			571			970			801			570			895			3,807

	£	s.	d.
Cost of "Maintenance Ration"—5 cows, 8 weeks, at 4s. 11½d. per cow, per week	9	18	4
Cost of "Milk Production Ration," for 3,807 lbs. at 2$\frac{4}{7}$d. per gallon	4	1	7
Cost of "Fattening Ration"—5 cows, 8 weeks, at 2s. 10½d. per cow, per week	5	15	0
Total cost of Ration ..	£19	14	11
Value of 454 lbs. live weight increase, at 4$\frac{3}{7}$d. per lb.	8	7	6½
Value of 3,807 lbs. Milk, at 8d. per gallon	12	13	9½
Total Returns ..	£21	1	4
Excess of Returns over cost of Food ..	£1	6	5

Result of feeding in the third period, the cows receiving "Maintenance Ration" and a "Fattening Ration."

	Cow No. 1.			Cow No. 2.			Cow No. 3.			Cow No. 4			Cow No. 5			Total.		
	cwts	qrs.	lbs.	cwts.	qrs.	lbs.	cwts.	qrs	lbs.	cwts.	qrs	lbs.	cwts	qrs.	lbs.	cwts.	qrs.	lbs
Live weight, Feb. 13th	12	1	1	9	2	17	12	1	7	10	2	0	10	1	22	55	0	19
,, ,, when sold [No. 1 after 40 days; Nos. 4 & 5 after 47 days; Nos. 2 & 3 after 54 days]	12	2	25	10	0	27	13	0	2	11	1	0	11	0	14	58	1	12
Live weight increase in the period.			52			66			79			84			76			357
Milk yield in period.			20			338			209			39			289			895

	£	s.	d.
Cost of "Maintenance Ration," 5 cows, av. $48\frac{2}{5}$ days at 4s. $11\frac{1}{2}$d. per cow, per week	8	11	5
Cost of "Fattening Ration" 5 cows av. $48\frac{2}{5}$ days, at 4s. $10\frac{1}{2}$d. per cow, per week ..	8	8	6
Total cost of Food ..	£16	19	11
Value of 357 lbs. carcase weight, at $4\frac{3}{7}$d. per lb.	6	11	9
Value of 895 lbs. milk, at 8d. per gallon	2	19	8
Total Returns ..	£9	11	5
Excess of Cost of Food over Returns ..	£7	8	6

No attempt has been made to draw out a complete balance sheet for any of the three periods. The residual value of the foods used is considerable, and this increases as the feeding becomes more liberal, since the food is devoted in an increasing degree to fat production. The values of homegrown and purchased foods must vary considerably from time to time and from place to place, and especially must the value of live weight increase be subject to wide fluctuations. The results for the three periods considered, however, should serve as a guide to the comparative profits which may be expected from the successive stages of the fattening process. With the values of milk, carcase weight and food taken, the limit for profitable production of milk is reached in the first period, the average yield of milk being then about eleven pints per cow daily. It may here be noted that the food required for maintenance, *i.e.*, food required to maintain the store condition of the cow, and by the consumption of which no return whatever is obtained—has a value in excess of that of a gallon of milk. It is due largely to this unproductive expenditure that a comparatively big return either in milk or flesh is required from each cow kept at a profit. The third period results show a decided loss when carcase increase is the main return for food fed. As is shown in the results of the second period, on approximately the same maintenance ration, and with a milk yield, which would normally decline, the cow may be made more profitable by utilizing her at one and the same time for the production of meat and milk. The milk yielded during this period completely covers the cost of the special " Milk Production Ration " and contributes 87 per cent. towards the cost of the " Maintenance Ration," so that should the value of the carcase increase cover the cost of the " Fattening Ration " and but 13 per cent. of the " Maintenance Ration " the animals would pay for food consumed. In comparing the returns in the first and second periods, it will be noted that the milk yield in the second two months falls but little short of that in the preceding two months, and this must be due in part to the increased ration. This is to the farmer's advantage, since the return in milk for the food consumed in the first period is much more satisfactory than the return in carcase for the food consumed in the third period. In fact,

in this last period the combined value of the flesh and milk produced, after paying for the "Fattening Ration," defrays but 13 per cent. of the cost of the "Maintenance Ration." On such a ration as allowed, with no returns in milk, an increase in live weight of almost two stones per week is necessary for profit. Such an increase would rarely be approached, and this suggests the impossibility of obtaining a profit by the fattening of dry cows on winter rations.

More value could have been attached to the figures had the number of animals been greater. The individual results for the separate periods are in fair agreement with the collective results, an analysis showing for the first period a loss on one animal, and a gain of from 4s. to 10s. on each of three others, for the second period a gain varying from 2s. to 11s. on each cow, while for the third period, a loss exceeding £1 is shown on each animal.

Some conclusions of practical value can be drawn from the results given.

The milk yield of a barren cow should not be allowed to reach an unprofitable level before a "Fattening Ration" is allowed. The introduction of such a ration to a cow in milk and already suitably fed will arrest the normal decline in milk yield, and that part of the ration devoted to maintaining the milk flow is assumed, from a consideration of the results of the first and third periods, to give better returns than that utilized for body increase.

So long as the cow returns a satisfactory profit on her milk, there is no necessity to introduce a fattening ration, for an equally profitable period can be secured by the addition of a "Fattening Ration" and maintained until the cow is almost or possibly quite ready for the butcher. The advisability of allowing a cow to dry off before sale as beef is a question difficult to decide, but certainly the results of the third period suggest the advisability of curtailing the interval between drying off and sale, and unless there is a marked difference in value between a fat cow in milk and a similar cow out of milk, it would be advisable to sell the fat cows direct from the milking herd.

THE USE OF MINERAL PHOSPHATES IN CALF REARING.

By A. H. Fairbairn, M.S.E.A.C.,
and C. Hutchinson, B.Sc. (Agric.) Lond.

An investigation into the value of mineral phosphates to supplement a typical ration for young store calves was commenced in November, 1913.

The whole question of the mode of action of the phosphates found in common foods and of the effects of added mineral phosphates, has long been under investigation at different experimental stations and the results published are not usually in agreement. The addition of tricalcic phosphate to the feed of young store pigs is commonly credited with being a valuable preventive to rickets and the popular opinion is supported by experimental results where the ration fed is low in phosphates. At the University of Wisconsin the rôle of inorganic phosphates in the nutrition of swine has been investigated, the conditions being specially arranged to offer ample opportunities for the added phosphate to exert a marked effect, the foods used containing as small a quantity of phosphate as could be arranged. The results obtained showed that store pigs receiving a ration poor in phosphate made as rapid gain in weight from about 40 lbs. to 100 lbs. as did those receiving a food richer in phosphate, and that when this weight was reached the pigs fell away and eventually collapsed. The addition of mineral phosphate to the food of similar pigs which had reached about 100 lbs. ensured normal growth to maturity.

Already numerous experiments have been conducted with a view to the determination of the effect of mineral phosphate to supplement the rations of young lambs and calves, and these have led to somewhat contradictory results. It seems established, however, that an addition of mineral phosphate either as precipitated phosphate or as tricalcium phosphate, to a calf ration poor in phosphate will exert a beneficial effect.

The absence of accurate quantitative knowledge of the phosphatic requirements of calves together with the high absorptive power possessed by all young stock for the phosphates contained in milk, suggested the desirability of ascertaining, as a preliminary to further work, the sufficiency of phosphate in a common economical ration for store calves.

The building used was adapted for the purposes of the experiment, each calf having a separate pen—six feet by five feet in size—with a feeding trough and hay-rack.

Air was admitted by means of shutters under the eaves of the roof, and these and the door were kept open whenever possible. In the roof were fitted skylights, which gave sufficient light.

The flooring was of cement, and the pens were littered with peat moss and straw. The pens were cleaned out, and washed out with disinfectant, twice a week during the early stages of the experiment, and later once a week.

Fourteen calves of Shorthorn type were bought for the experiment. The animals were grouped to compare as closely as possible for age, breeding, sex, and size, and were divided into two lots, known as Lots I. and II., arranged alternately in the pens.

The calves were fed three times a day, at 6.30 a.m., at 12 noon, and at 5 p.m. Special care was taken at the commencement to feed the milk at body temperature. All pails used in feeding were scalded after each meal.

The health of the calves was on the whole very satisfactory. Three calves were affected with scour; one died, and the others recovered very quickly. A few slight cases of scouring occurred from time to time and were treated in the following manner :—A dose of castor oil was administered and the milk diet was slightly lowered for a day or two. The pens were cleaned out daily as long as the scouring continued.

On February 3rd, a calf from Lot I. developed pneumonia, and as he never fully recovered it was decided to remove both him and the corresponding calf from Lot II., from the experiment.

The actual feeding ration of both lots was the same, and a full account of it is given in the table below. This system should be sufficiently good to produce good store calves.

To the ration of the calves in Lot II., phosphate was added equal in quantity to that contained in the food then fed to the calves. From January 27th onwards double the phosphate of the food was added. Each calf of Lot II. received about 1 oz. of the added phosphate daily. The mineral phosphate used was Precipitated Calcium Phosphate—and was in a fine dry condition.

The phosphate was added to the linseed porridge as it was made up daily and was fed in the milk.

The feeding allowed per calf per day is tabulated on the next page. In all cases these allowances were made and any food left unconsumed was removed. The preference certain calves show for certain foods is very noticeable. The ration is quite sufficient for a calf growing at the rate of 1½ lbs. live weight per day, a very good rate of progress for store calves (*see p.* 173).

The following table shows the record of monthly weighings and increases. The calves were weighed weekly.

The addition of the phosphatic food to the ration was commenced when separated milk was first introduced, *i.e.*, after the end of the third week, and the figures given in the following table date from this period.

WEIGHTS AND GAINS DURING MONTHLY PERIODS.

Date.	No. of Lot.	Average weight per Calf in lbs.	Average Increase per Calf in lbs. since previous weighing.	Average weekly increase per Calf in lbs. since previous weighing.
December 3rd 1913	Lot I. Lot II.	121 121		
December 31st	Lot I. Lot II.	152½ 153	31½ 32	7.87 8.0
January 28th 1914	Lot I. Lot II.	193½ 195	41 42	10.25 10.5
February 25th	Lot I. Lot II.	233½ 235	40 40	10.0 10.0
March 25th	Lot I. Lot II.	251 250½	17½ 15½	4.37 3.87
April 1st	Lot I. Lot II.	259½ 262	8½ 11½	8.5 11.5

FEEDING FOR STORE CALVES.

Age.	Feeding—Morning and Evening.	Feeding—Mid-day.	
1 week ..	4 lbs. New Milk ..	As morning ..	The changes of feeding are all made gradually.
2 weeks ..	4½ lbs. New Milk ..	As morning ..	
3 weeks ..	5 lbs. New Milk ..	As morning ..	Linseed Porridge is made by adding to 2 lbs. Linseed Meal and 1 lb. Maize Meal, boiling water until the volume is 1 gallon.
4 weeks ..	3 lbs. New Milk .. 2 lbs. Separated Milk .. ½ pint Linseed Porridge ..	As morning ..	
8 weeks ..	4 lbs. Separated Milk .. ¾ pint Porridge .. ½ lb. Hay ..	Milk and Porridge as morning .. ¼ lb. Concentrated Food ..	The Concentrated Food consists of equal parts of Linseed Cake and Crushed Oats.
12 weeks ..	4 lbs. Separated Milk .. ¾ pint Porridge .. 1 lb. Hay .. ¼ lb. Concentrated Food ..	2 lbs. Separated Milk .. ½ pint Porridge .. ½ lb. Concentrated Food ..	
16 weeks ..	4 lbs. Separated Milk .. ¾ pint Porridge .. ½ lb. Concentrated Food .. 1 lb. Hay ..	1 lb. Concentrated Food .. 2 lbs. Hay ..	The quantities of Hay given are the full amounts the calves will eat.
20 weeks ..	¾ pint Linseed Porridge in water 2 lbs. Meadow Hay .. 1 lb. Concentrated Food .. 5 lbs. Roots ..	1 lb. Concentrated Food .. 3 lbs. Hay ..	

Average gain in weight per calf in 17 weeks, Lot I., 138½ lbs., Lot II., 141 lbs.

Average weekly gain in weight per calf in 17 weeks, Lot I., 8.15; Lot II., 8.3.

The weather conditions prevailing throughout the second and third weeks of March were of a very wet and cold description, and the little progress made during March is attributed to this cause.

The figures given in the foregoing table show that the addition of the mineral phosphate gave no marked increase in rate of progress of the calves receiving it as compared with the control lot, the slight advantage being well within the limits of experimental error.

The food consumed by each calf for 17 weeks from the commencement of the experimental period and the cost of the same are given below.

			£	s.	d.
New Milk	..	21 galls. at 7d. per gallon		12	3
Separated Milk	..	95 galls. at 1d. ,, ,,		7	11
Linseed Meal	..	52 lbs. at 18s. per cwt.		8	4
Maize Meal	..	26 lbs. at 6s. ,, ,,		1	5
Oats	..	66 lbs at 18s. per quarter		3	6
Linseed Cake	..	66 lbs. at £8 5s. per ton		4	11
Hay	..	294 lbs. at £2 ,, ,,		5	3
Total cost of Food from the age of 3 weeks to 20 weeks			£2	3	7

Average live lot gain in 17 weeks of the two lots of calves :—
140 lbs.

Cost per lb. live lot gain in this period, 3.73d.

We are deeply indebted to Mr. A. Hartley, Emsworth, Hants, for supplying us the phosphate used. This is his own preparation, and is sold under the name "Phosto."

WYE COLLEGE FRUIT EXPERIMENT STATION.

By R. Wellington.

Introduction.

It has been only during the last twenty years that systematic experimental trials have been undertaken in this country with regard to the economic production of fruit crops.

The Woburn Experimental Fruit Farm, founded by the Duke of Bedford in 1895, was the first institution in the British Isles to investigate these problems. This station is situated at Ridgemont, in Bedfordshire. Mr. Spencer Pickering, who has been the Director from its commencement, has arranged the trials in order to obtain some idea of the principles which underlie the general practice adopted in the cultivation and growth of fruit trees. The problems which have been investigated all ultimately affect economic fruit production. The trials which have been made have dealt with the various methods of cultivating the land previous to and after planting, of planting, of the value of various manures, and of the many methods of pruning. Besides these trials, work has been undertaken to ascertain the comparative value of the various insecticides and fungicides, and of the chemical and biological reactions which in many cases are responsible for their beneficial effect.

The only other Experiment Station, excluding trial plots, devoted to the investigation of problems relating to fruit crops, which has been working for some years, is the National Fruit and Cider Institute at Long Ashton, near Bristol. This institution was founded in 1903, and has been supported by grants from the Board of Agriculture and from a number of local County Councils and Agricultural Societies. Until quite recently the trials and work carried on at this station have been largely confined to problems affecting cider-making

and the growth of cider-fruit. This institute has recently associated with the University of Bristol, and now serves as the Agricultural and Horticultural Research Station of the University. The Board of Agriculture have selected it to form the nucleus of a Central Fruit Experiment Station for the whole country, and their scheme will be complete when sub-stations have been organized in each of the many fruit-growing localities. The Development Commissioners have provided the Board of Agriculture with sufficient money to maintain these stations.

When it became known that the Board of Agriculture contemplated the foundation of a Central Fruit Experiment Station with supplementary sub-stations, a deputation of fruit-growers from Kent, Surrey and Sussex waited on the President and urged him to select Kent for the situation of the central station. The Board of Agriculture, however, as mentioned above, selected the West of England for the site of this station. The result of further deputations was the promise of a grant of £500 per annum towards the maintenance of a research station for the South-Eastern Counties, provided a similar sum was raised locally. From the first it was considered impossible to collect locally a certain £500 per annum, and after some further negotiations the Board agreed to allow a capital sum of £2,500 to be raised in lieu of the annual amount. Of this £2,500, the Kent County Council has provided £1,500. This sum was placed in the hands of the Kent Education Committee and has been sufficient to buy twenty-two acres of unplanted arable land. The remaining £1,000 has been generously guaranteed by Mr. F. S. W. Cornwallis, Chairman of the Kent County Council. It is hoped to raise this amount by private donations and a sum of £570 has already been received towards it. Possession of the land was obtained in March, 1913, and it is therefore rather more than a year since the work of planning and planting was commenced.

Situation and General Description.

The land was part of Ditton Court Farm, belonging to the late Mr. T. Scott, and formed the field known as "Great East." It had previously been cropped throughout on a

modified four-course rotation. The field is situated close to the Eastern boundary of the Parish of East Malling. It is four miles by road from Maidstone, thirty-two miles from London, and lies about one mile to the South of the main London-Maidstone-Folkestone road, from which it may be reached by a bye-road. This bye-road leaves the main road at Ditton Corner, just previous to the thirty-first milestone from London. The land is about one-and-a-half miles South-West of the river Medway and of Aylesford Station on the North Kent line of the South-Eastern and Chatham Railway. It is about half-mile by footpath from East Malling Halt on the Swanley-Maidstone-Ashford branch of the same railway.

The Fruit Station thus lies in the Valley of the Medway on the denuded slope of the Kentish Ragstone Hills. The general slope of the land towards the river is quite gentle and of a northerly direction. Besides this, there is a side-slope towards the North-Western corner. The South-Eastern corner has therefore the highest altitude and is 137 feet above sea level. The diagonal fall across the land to the North-Western corner is twenty feet. The boundary along the Northern and Eastern sides consists of a spile fence, 5 ft. 6 in. high, which has been erected since possession of the land was obtained. Along the Northern side, the arable land belonging to Sir John Twisden is separated from the Fruit Station by the footpath which runs from East Malling to Maidstone. Along this boundary nineteen large elm-trees were growing when possession of the land was first obtained. These trees rendered a considerable area of land useless for trial purposes, but thanks to the generosity of Sir John they have recently been felled and removed. Owing to the natural slope of the land, and as there are now no trees in the immediate neighbourhood of these boundaries, the aspect to the North is somewhat exposed. A poplar lew-row will therefore be planted to afford shelter. The Swanley-Maidstone-Ashford branch of the South-Eastern and Chatham Railway runs along the Southern boundary on the embankment about 15 feet high and affords some shelter from the South-Westerly gales. On the Western boundary is a grassed cherry orchard approaching its prime, which belongs to Mr. W. L. Wigan. The actual boundary on

this side is a low quick hedge. On the Eastern boundary is arable land very similar to that of the station belonging to the executors of the late Mr. Scott.

The previous cropping and cultivation of the land has been as follows:

1909.—Potatoes and Mangel.
1910.—Wheat.
1911.—Seeds ley.
1912.—Oats (Besseler's Prolific).
1913.—Peas (Gray).

The seeds were completely burnt in August 1911, having been set alight by a spark from a passing train. According to the late Mr. Scott's methods of farming, the land was dunged (about thirty tons), gaslimed, ploughed and sub-soiled for the root crops in 1909. Small pieces of gas-lime from this dressing can still be found. The method of subsoiling adopted is locally known us "grubbing," and consists of breaking up the base of the open plough-furrow with a narrow cultivator. The wheat land in 1910 was ploughed and the seed sown broadcast. The seeds for the 1911 ley were of course sown under this wheat crop. The seeds ley, which was down one year during 1911, was hayed once. It was ploughed up during the early part of 1912, and the oats were sown broadcast and harrowed in during the spring. A dressing of Nitrate of Soda and Nitrate Salt was distributed over the oats. After harvest, the oat land was broadshared and ploughing followed in the spring. The peas were drilled immediately possession of the land was obtained. These received a dressing of 2 cwts. per acre (35 per cent.) superphosphate of lime. During last winter (1913-1914) about seventeen acres of the land adjoining the southern boundary received a light dressing of dung (10 tons) and were later ploughed and "grubbed."

Of recent years all the ploughing has been done with a digger plough and by a two-horse team. The general cultivation of the land has always been deep, and on this account the soil proper approaches a depth of one foot.

A large number of small pieces of chalk can be found in the soil. These are the remains of a heavy dressing which was given about 1879, when the late Mr. Scott first became tenant of the farm.

The soil overlies the Hythe beds which are grouped in the cretaceous geological series. These beds are composed of sandstone rock, locally known as Kentish Rag. The grains of sand are cemented together by lime. The rock is very variable, but may roughly be divided into two kinds. It is either very soft and easily broken, when it is known as "hassock," or else very hard, brittle or shattery. The "hassock" is not of much economic value except for making road and yard bottoms, but the hard rock is quarried for use as a building stone and to be manufactured into tar macadam. The hard rock runs in seams which are interspersed with layers of "hassock." There are a number of stone quarries worked in the immediate neighbourhood of the Fruit Station. Much of the rock contains a comparatively large quantity of lime and was extensively used at one time for lime-burning. This fact is illustrated by the number of disused lime-burning kilns which may be found in the district. This type of lime is no longer burnt on account of the ease with which a cheaper article can be obtained from the many cement works in the lower reaches of the Medway Valley. The soil of the Fruit Station is not derived from the weathering of the Kentish Rag Rock, but is a drift soil, which has been transported by some agency, probably water, and deposited overlying the rock. Soils derived from the Ragstone rock are usually shallow, hungry, tenacious when wet, and contain a large number of shaley pieces of stone, which are portions of the weathered rock. Such soils can be found within a short distance of the Station, but are always higher up the slope. If well manured, such land is particularly suitable for the growth of apples, plums and nuts.

The depth of soil at the Fruit Station varies from about six feet at the South-Eastern corner to about three feet six inches at the North-West. Hassock is found at this depth. One could describe the soil as a light friable loam, requiring to be "done well" to obtain good results. The following is a description of the composition of the soil :—

Soil proper	..	1 foot thickness.
Subsoil	..	1 foot to 1 foot 7 in. thickness.
Sandy layer	..	6 in. to 1 foot 6 in. thickness.
Brick earth	..	7 in. to 2 feet 2 in. thickness.

The soil and subsoil are light red-brown in colour and contain few stones. If worked when wet, the soil on drying is liable to become "steely" on the surface. This loss of condition may be prevented by judicious harrowings. The sandy layer is of a light yellow-brown colour and contains a few angular pebbles. In some of the trial holes which were dug the lower portion of this layer was of a gravelly nature composed of small angular and water-worn flints. The sandy layer is chiefly composed of sharp particles, and its extent was easily distinguished by its texture on the exposed section of the hole. The brick earth layer is quite typical. It is sticky when wet, of a bright red colour and contains a few ragstone pebbles besides some small angular flints. There is no doubt that it is this layer which is chiefly responsible for the retention of moisture in the soil. Immediately below the brick earth layer hassock is found. A very comprehensive series of soil samples and analyses is being made, but as this is not yet complete it will be described in a future report.

The land was selected for the site of the Fruit Station after its suitability for the purpose had been thoroughly considered. The chief reasons for the selection of this particular piece were on account of—its flatness, even soil texture and depth, aspect, previous uniform cropping and situation in a large fruit-growing district, besides its acknowledged suitability for fruit culture.

Research Work.

The actual trials and work which it is intended to carry out at the Station will be mainly confined to the study of problems which are met with in the actual culture or growth of fruit trees and bushes. Such problems are related to the Physiology of these crops. The aim of these trials is to find out the principles which underlie such operations as pruning, methods of propagation, the use of fruit tree stocks and other strictly cultural details. The information obtained will lead to a better knowledge of the conditions which affect either directly or indirectly the crop-bearing capabilities of the various kinds of fruit trees, and also the quality and usefulness of the produce. It is not proposed to plant plots for special mycological or entomological work. Problems of this nature are

already amply dealt with by the Advisory and Research departments at Wye College; opportunities will, however, doubtless be obtained in the course of time for the study of several pests when the various plots at the Station become attacked. Neither is it intended to plant the usual variety demonstration plots. These are much more appropriately dealt with at such institutions as the Royal Horticultural Society's gardens at Wisley, Surrey. Furthermore, the plots will be arranged so that the trials are only carried out with the chief commercial varieties. It is intended to organize the work so that problems of economic importance are chosen for study rather than those which have only a scientific value.

The position of the worker who studies problems relating to the growth and general culture of plants or trees requires some explanation. Agricultural research workers, be they ever so careful, have always experienced great difficulty in arranging strictly comparable trials in order to obtain results which give a true indication of the effect of the particular operation with which they are dealing. The effect of variable soil, climate and aspect conditions, together with the individuality which each tree or plant possesses, to mention a few of the factors, is often so great as to mask the true result. The difference between the actual results obtained and the true results which it would be possible to obtain if these factors were all uniform, is known technically as the *experimental error.* In the case of ordinary cereal crops this error may be reduced to within reasonable limits by carrying out the trials during several seasons and on a large number of individual plants. The average results which are then obtained have only a very slight error due to individuality, seasons and local soil variations. For the results to have a wide application, the trials must be similarly repeated over a wide range of soils, and the average variations noted in each case. In the case of trials with fruit crops, the experimental error is of necessity large. Results having wide application can seldom be obtained, chiefly owing to questions of time and cost. The trials also cannot be repeated annually with a fresh series of individuals. Moreover, the few units which it is possible to include in the trials cause a large error to arise, due to individuality. This error is further increased by the large and

variable area which each tree or bush occupies, and the consequent introduction of an environmental effect. It must be the first aim, therefore, of those engaged in planning these trials to control as much as possible the factors which are subject to variation. There are a number of factors which, if our present knowledge is only increased slightly, are amenable to control. In certain problems therefore it will be found necessary to arrange preliminary trials before the actual investigations can be commenced. In other cases, similar trials must be made to find out the special conditions which by affecting growth are able to produce considerable variation in the results obtained in the main investigation. For example, it is impossible to find out the underlying principles of pruning before the life-histories of the wood and fruit buds are investigated. Further, these life-histories cannot be fully outlined until one knows the combined effect which soil, climate, and the type of root-stock used produces on the growth of the tree.

It will be fully realized by now how important it is to understand thoroughly the fundamental principles controlling growth before other more complex problems can be attacked. The organization of trials on these lines necessarily causes slow progress and involves a delay in the attainment of results. But the conclusion of such work when accomplished is certain to produce results of much greater value than by the slap-dash commencement of the most complex problems without preliminary trials.

The organization of the work and the planning and planting of the land at East Malling has been arranged with these eventualities in view. Results from the major portion of the actual trials cannot be expected for some years. The fruit-growers, however, need have no cause for impatience. With the buildings and the facilities which the Station has at its disposal, work can be commenced on problems which either require no direct trial involving a series of years, or which can readily be investigated in the grower's own plantation. The results from such work may be expected within a few years, during the maturation of the main trial plots. It must not be thought, therefore, that the Fruit Station will only be of value in the future, it will be of actual use to the grower at the present time.

The main problems for which trials have been arranged relate to the effects which the root-stock produces on the scion with which it has been worked. These problems are undoubtedly of immense importance. They control its rate of growth, its increased or decreased prolificacy, its early maturity, its disease resistance, the colour of its fruit, and its general adaptability to varying soils and methods of culture. The practices of grafting or budding the desired variety on to a developed root-stock came into use in the first instance because they offered easy means of propagation, and not on account of any influence which the stock might exert on the scion. The chief domestic varieties of our hardy fruits cannot be economically propagated by other vegetative means except with great difficulty, and as in many cases they do not breed true, propagation by seed is useless. The root-stock chosen has of necessity always been of a closely related variety or species, and has been selected on account of its easy propagation by seed or vegetative means. The use of root-stocks as a means of propagating our domestic varieties is as necessary as ever, but we now know that a wide range of variation may be obtained in the grafted or budded tree, according to the nature of the root system on which it has been worked. These variations may be further influenced by the affinity which the scion bears to the stock.

At present the type of stock is varied to suit special soil conditions and methods of cultivation, but we have no definite knowledge of the comparative value of each variety. The importance of these problems calls for careful study and the confirmation or modification of our present casual observations on which the selection of stocks is at present based. Furthermore, the various types have never been carefully classified, and the names of supposed varieties are used for widely varying types. As a result of this latter state of affairs it is impossible to obtain trees for experimental planting which are guaranteed worked on true and selected stocks. Until the classification of these stocks is accomplished the experimental error in fruit tree trials is therefore necessarily increased.

About one-and-a-half acres of the land at the Station have been devoted entirely to the classification and propa-

gation of stocks, while about twelve acres will remain unplanted, until it is possible to raise sufficient trees worked on selected stocks to allow the various plots to be laid out. Such a plantation will be of immense experimental value. It will allow the commencement of comparative trials to obtain some idea of the most suitable stocks for the various varieties. Simultaneously, pruning and cultural trials can be arranged over the series of plots. The results obtained from these plots will be comparable in the highest degree.

The chief kinds of hardy fruits which are propagated by the grafting or budding on to a root-stock are the apple, the plum, the pear, and the cherry. The root-stock problem varies considerably in each case.

The apple is commercially the most important of these fruits and its stock problem has therefore a very wide application. The apple stocks at present used are very variable and present a somewhat complicated problem. They may be divided, as far as we know at present, into two distinct classes—the "dwarfing" stocks, which are suitable for shapes such as bush, pyramid or cordon trees; and the "strong-growing" stocks which are used for standards or half standards. The "dwarfing" varieties are usually termed "Paradise" stocks, and would, if allowed to grow, form small bushes or trees. Their chief characteristics are that they can produce adventitious roots with great ease and that their root-systems when formed are composed of an enormous number of small surface-rooting fibres. On the other hand, the strong-growing types, usually known as "Crab" or "Free" stocks, form trees of normal size. In contrast to the "Paradise" stocks, they are unable to produce adventitious roots easily and the root-systems they form are composed of large roots spreading over a wide area.

Theoretically, the selection of the stock depends on the type of root-system which it produces. The influence which the stock exerts on the scion should vary according to the system of rooting. The effect of the "dwarfing" stocks will tend to check growth and cause the tree to fruit more quickly. The "strong-growing" types are more normal and cause the production of growth during the early years of the tree's life, with a consequent delay in fruition, at any rate, until it is

fully formed. By classifying the various stocks according to the strength of growth they produce, it should be possible to arrange them according to their adaptability for special varieties and for the various methods of cultivation. The problem is, however, complicated in a number of ways. Stocks of the two types already mentioned are in constant use. The varieties of each type used by nurserymen, however, depend not so much on the effect they produce on the trees, but first on the degree of ease with which they can be raised, and then upon the supplies which are on the market. The majority of stocks used by commercial nurserymen are bought in from firms devoting special attention to this class of work. Nurserymen undoubtedly try and buy vigorous and well-grown samples, but in few cases is special attention paid to the variety they are obtaining. This question of ease of propagation which causes the present varieties to be used is really an economic one. Growers will have cheap trees, although a few shillings extra per hundred are of little account when the value of the mature orchard or plantation is considered. The commerical nurseryman, with keen competition to consider, is obliged to raise his trees at the lowest possible cost. The stock raiser must therefore produce his supplies also at a very low cost. One cannot expect him to grow special stocks and to adopt more expensive methods of propagation if the article he produces does not return him an enhanced price, notwithstanding the fact that the stocks so raised may be of greater ultimate value to the fruit-grower. As a result of this state of affairs the present method of obtaining stocks will continue in use as long as the fruit-grower is satisfied with his supplies.

The present methods of raising the "dwarfing" or "Paradise" apple stocks are fairly satisfactory. They are raised vegetatively from either layers or cuttings. The nomenclature and classification of these stocks are, however, very mixed, and their comparative value is unknown. Yet by selection and trial true strains of the various varieties can be quickly obtained and tested. The other class of apple stocks, namely, the "Crab" or "Free" stocks, are at present raised by seed. These stocks, besides requiring similar systematic work for their classification, must be raised by some commercial means of vege-

tative propagation for the results of such work to have any permanent value. It is however probable that the Crab or Free Stocks raised in this manner will be slightly more expensive than those raised by seed. The raising of any class of fruit tree stock from seed is most unsound. The majority of the fruits we grow are of "multiple origin," that is to say, they are unable to breed true even if self-fertile. The seedlings obtained from them therefore offer a very wide range of types. The difference between the two classes of "strong-growing stocks"—the "Crab" and the "Free"—is solely a distinction referring to the origin of the seed. The "Crab" pips are obtained from so-called "Crab-Apple" fruits. The trees producing these fruits are usually found growing wild and are characterized by spiny growths, small leaves and small fruits. What relation these co-called "Crab-Apples" bear to the ordinary domestic varieties it is difficult to say, but they are either true wild species or else chance seedlings of domestic varieties. The "Free" stocks, on the other hand, are obtained from the seed of cultivated varieties, usually obtained by washing cider "pomace." The variation to be found in the seedlings of either of these kinds of stocks is very wide. The colour, size and shape of the leaves, the colour of the wood, the strength and habit of growth, the colour and shape of the buds, the fruit they produce and finally the habit of rooting, are some of the characters subject to variation. The variability of the last character is of much importance from the stock point of view. As a class these stocks are used because the majority develop a deep and strong root system which causes the scion to grow vigorously. Stocks which exhibit this characteristic as a rule produce adventitious roots with great difficulty, and as a result cannot be raised economically by the usual vegetative means. Hence propagation from seed is the method at present adopted. Specimens developing the "free" or "ease-of-rooting" characteristics of the "dwarfing" class are always to be found on careful examination in a bed of stocks of this type. It may be possible, therefore, to obtain stocks which, while exhibiting the deep-rooting tendency of the one type, possess also the ease of propagation of the other. In this way a pure strain could be raised vegetatively and propagation from seed abandoned. Time will show whether this is possible of attain-

ment. The fact that fibrous-rooting specimens appear in beds of seedlings raised from "Crab" or "Free" pips is interesting from another point of view. It is possible that the present varieties of "dwarfing" stocks have probably been obtained by selection from seedlings in this way. If this is the case, then it will be a means of obtaining new varieties which may have more developed valuable characters than in the types at present in use.

For convenience of work, the apple-stock problems already mentioned are being jointly investigated by the East Malling Station and that at Long Ashton. The work on "Paradise" or "dwarfing" stocks will be dealt with mainly at Malling, while the station in the West of England will be chiefly concerned with the "strong-growing" types. The work on apple stocks is being carried out in collaboration with Professor Barker, of the Agricultural and Horticultural Research Station, Long Ashton, Bristol, and the results will be communicated in a single report.

The work on the "Paradise" stocks has been commenced in the following manner. During the winter 1912-13 a collection of many varieties and kinds was obtained from nurserymen throughout the country. During the past winter these have been further supplemented by types from Germany, France and Holland. Of this collection a portion of stocks from each source have been planted out in rows six feet apart and four feet in the rows. Each individual, after growing a year to become established, will be cut down to within a few inches of the ground. In this way a stool is formed. The strong basal growths which are produced can be earthed up to form rooted layers. Each individual stool will be carefully examined and recorded, and by keeping the layers obtained from each quite separate, true strains will be raised. The classification of these stools can of course only be made according to the vegetative character of each. In order to see what variation there is in the flowers and fruits, a number of specimens from each source have been planted out for growth as cordons.

Although the work of classification cannot of course be complete for a number of years, it promises to be more rapid than was originally anticipated. The stocks

which were obtained during 1912-13 have been recorded and roughly classified for the first time, where normal growth has been made. As it will not be possible to publish these descriptions at present, all interested in these problems are invited to visit the Station and compare the various types. The classification of the stocks in the way already described is only the commencement of the work. As soon as sufficient stocks of each strain can be raised they will be "worked," and the "maiden" trees so obtained planted out for trial. It is proposed to work the stocks for comparative trial chiefly with the varieties, Bramley's Seedling, Allington Pippin and Lane's Prince Albert. These varieties are considered to represent trees with strong, medium and weak vigour of growth. An indication of the root-effect of each type of stock in relation to the strength and growth of the scion will be obtained in this way. The collection of "dwarfing" stocks is composed of :—

Broad-leaved English Paradise	obtained from	19 sources
English Paradise	,, ,,	3 ,,
New Paradise	,, ,,	1 ,,
Paradise	,, ,,	8 ,,
Doucin (Doucin d'Anger) ..	,, ,,	6 ,,
French Paradise	,, ,,	2 ,,
Nonsuch Paradise (Rivers' Nonsuch Paradise and Rivers' Paradise)	,, ,,	5 ,,
Paradise Jaune de Metz (Metzer Paradis)	,, ,,	2 ,,
Roter Paradis	,, ,,	1 ,,
Gelber Paradis	,, ,,	1 ,,
Improved Doucin	,, ,,	2 ,,
Schwartze Paradis	,, ,,	1 ,,

besides a number which have been selected but not named.

The stocks used for plums by the commercial nurseryman are few in number and one is unable to divide them sharply into classes according to their type of root-system or effect on the tree, as with apple stocks. This is due to the less conspicuous influence which they exert on the scion. The

individual varieties are, however, quite distinct, and as a result there is no confusion in their nomenclature or description. The stock problem of the plum is, therefore, much less complicated than that of the apple. No preliminary selection is necessary and the comparative trials can be commenced as soon as the stocks are available. Plum stocks, with the exception of the Common Plum, are commercially propagated by vegetative means either from suckers or root cuttings. In the exception mentioned the stocks are grown from "pits" or stones, and as a result exhibit variations. These stocks could very probably be raised vegetatively without much difficulty. The choice of the plum stocks by the fruit-grower, in comparison with that of the apple, does not depend so much on its adaptation to the required shape of the tree or to the type of soil to be planted as on its affinity to the variety chosen. To explain, one would not vary the type of stock for planting on either heavy or light soil, but the choice would be influenced by the variety to be worked. From casual observations, it appears probable that this choice plays an important part in the setting of the blossom and the maturing of the fruit.

The individual varieties have been collected during the past winter and have been planted out to form stools. These varieties consist of—

Pershore	1	source.
Brussels	3	,,
Mussel	3	,,
Brompton	1	,,
Myrobalan	1	,,
Mariana	3	,,
Common	2	,,
St. Julian	2	,,
Black Damas	1	,,
Damson (Cluster)	1	,,

The various types of quince which are used as pear stocks have also been collected during the past winter. These are all propagated by vegetative means and have been planted out to form stools. Their comparative values will be ascer-

tained from trials arranged in a similar manner to the plums. The varieties which have been obtained consist of :—

d'Anger.	Pear-shaped.
de Fontenay.	Apple-shaped.
Common.	Portugal.

Besides this main work which relates to root-stock trials, considerable attention has been paid to a number of other problems. About an acre of land has been planted during the past season with "maiden" apple trees at fourteen feet square.

This plot, which it is intended to extend during the coming autumn, will be used for pruning trials. The varieties already planted include :—

Newton Wonder	stock—Broad-leaved	English	Paradise.	
Beauty of Bath	,,	,,	,,	,,
Allington Pippin	,,	,,	,,	,,
Worcester Pearmain	,,	,,	,,	,,
Grenadier	,,	,,	,,	,,
Worcester Pearmain	,,	Crab.		
Grenadier	,,	,,		
Lane's Prince Albert	,,	,,		

It has been decided to carry out normal methods of pruning and general cultivation for the next three or four years. The trees by this time will have formed their main branches. The pruning trials will therefore be commenced as soon as the foundation of the tree is firmly laid. The trees will be trained in bush shapes and the land will be kept in cultivation. The trials carried out on these trees will be arranged solely to demonstrate the effect produced by pruning back the "leader" (the leading shoot of the branch) to varying extents. The pruning for "spur-formation" and to keep the tree shapely will be similar throughout the plot. The "leader" will be pruned back to the following extents :—

(1) The removal of about three-quarters of each year's growth—extremely hard pruning.

(2) The removal of about half of each year's growth—moderately hard pruning.

(3) The removal of about one quarter of each year's growth—"tipping."

(4) The non-pruning of the leading shoot.

The actual trials on a similar plot have already been commenced at the Fruit Plantation at Wye College with very interesting results. This plot at the Fruit Station will be more extensive and the trials will be made on a larger number of varieties. As the trees develop this plot will furnish abundant material for the study of physiological problems relating to apple pruning.

During the winter 1911-1912 much information was obtained with regard to the growth of Black Currants in various districts in the country. This information dealt with general cultural methods, and special reference was made to the "running off" or premature falling of the fruit. Apparently this phenomenon is not peculiar to any special variety, or to peculiar soil, climatic or aspect conditions. It assumes an intensified form, however, in many cases, and is more serious on some varieties than on others. The crops of the French and Boskoop Giant varieties suffer especially severely. The work on this problem has consisted in numerous pollination experiments, the commencement of manurial trials and the growth of cuttings to form variety plots to ascertain varietal intensity. In connection with this work, a large number of black currant seedlings have been raised and will be tested in the course of time. It is hoped to report on this work during the coming year.

A small plot of gooseberries, consisting of the varieties, Berry's Early Kent, Cousin's Seedling, Crown Bob, Lancashire Lad, Whitesmith, Whinham's Industry and Yellow Rough, has been planted. It was originally intended to use this plot for trials in connection with work on the spray damage caused by lime-sulphur summer wash. It has since been decided to use the bushes for pruning experiments.

A small portion of the land has been planted with new varieties of hops, which have been raised at Wye College. In the course of time about an acre will be used for this purpose.

To conclude, the Fruit Station consists of twenty-two acres of land of which about four acres are already devoted to fruit trials and about a quarter of an acre is planted with hops. Of the remainder, twelve acres are cropped with strawberries, four acres with oats and lucerne, and the remaining half-acre is occupied with buildings and roadways. The land has been

spile-fenced on two sides, and has been completely surrounded with wire-netting. Water has been laid on from the Mid-Kent Water Company's main supply. The brick and tile buildings which have been erected consist of office, laboratory, tool-shed, hay-store, stable and cart-shed. These buildings are now completely equipped. The erection of a foreman's cottage is all that is necessary to complete the original scheme for the development of the Station.

The staff of the Station at present consists of the Director, Superintendent and labourers ; casual labour is obtained when required. A research student will be attached to the Station as the work proceeds.

REPORT

ON

ECONOMIC ZOOLOGY.

FOR THE

YEAR ENDING SEPTEMBER 30th, 1913.

BY

FRED. V. THEOBALD, M.A., F.E.S., etc.

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INTRODUCTORY NOTE.

The present report deals with some of the enquiries received between October 1st, 1912, and September 30th, 1913. Comparatively few of the communications have contained any special features of interest. The majority have been in connection either with spraying or such common pests as Wireworm, Surface larvæ, Onion Fly, Cabbage Root Maggot and such like.

A large number of communications have been received concerning the Woolly Aphis, practically all of which will be dealt with in a special report to be issued at the end of 1914.

All correspondence dealing with the Nettle Head Disease in Hops has been handed over to Mr. Alban Duffield, F.E.S., who is investigating this disease in the Weald of Kent.

The Flea Beetle investigations started by Mr. Mason are also being continued by Mr. Duffield.

A mass of correspondence connected with the *Aphididæ* has been received from Britain and abroad, and large numbers of specimens have been collected. The genera Macrosiphum, Rhopalosiphum, Cavariella, Amphorophora, Drepanosiphum, Phorodon and Hyalopterus have been completed and the first volume of a Monograph of the British Aphides will be published privately during the year.

My thanks are due to the Rev. E. N. Bloomfield, M.A., F.E.S., Mr. Britten, F.E.S., Mr. Richard South, F.E.S., Dr. Mordwilko, of St. Petersburg, Professor Davis, and Miss Edith Patch, of the United States, and Dr. Trägårdh, of Stockholm, for help given me in identifying specimens.

Mr. Edenden of Wye has taken the photographs.

FRED. V. THEOBALD.

Wye,
April 2nd, 1914.

ANIMALS INJURIOUS TO FRUIT TREES AND BUSHES.

APPLE PESTS.

Hop Dogs (*Dasychira pudibunda*) attacking Apple Trees.

On September 25th I received from Hownhall Fruit Farm, near Ross, Herefordshire, a number of Hop Dogs, the caterpillars of *Dasychira pudibunda* (Fig. 1), with a note saying they were attacking the bush apple trees there. They were of three well marked varieties and not quite full grown,

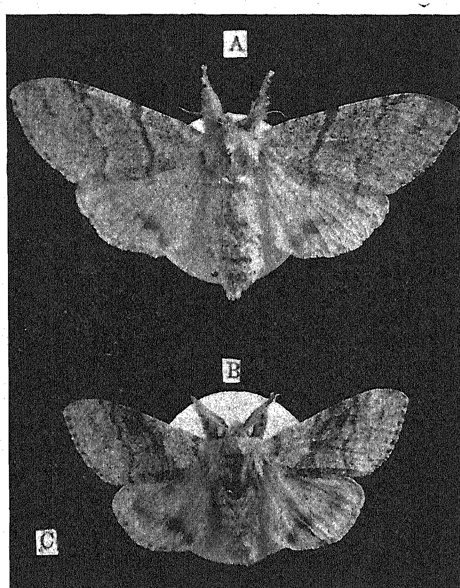


Fig. 1.
PALE TUSSOCK MOTH (*Dasychira pudibunda*); female, A; male, B.

continuing to feed for another ten days or so, the first pupating in a cocoon amongst the apple foliage on October 5th, the last on October 12th.

They devoured the apple foliage given more rapidly than they usually do hop or other foliage I have found them on, and seemed to relish it. Some hop bine was put in with them, but they all remained on the apple, and finished their growth there, instead of moving as I expected to hop, birch and elm placed in their cages.

I am not aware of any record of this moth caterpillar feeding on apple, in any case there is no record of their having been noticed doing any damage as in this case.

The cocoons were left amongst the apple foliage, which had become attached to the shoots by the floss silk, and they

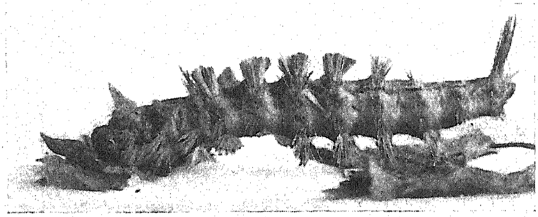


Fig. 2.
LARVA OF PALE TUSSOCK MOTH OR HOP DOG.

commenced to hatch out on January 10th, and the last on February 7th. A male and female were found in copula on January 14th, and the female laid about forty eggs on January 15th, 16th, and 17th. Others oviposited up to February 1st. The general food plants of these caterpillars are the following:—elm, alder, hornbeam, and beech, and as one of its common names—the Hop Dog implies—the hop.

The beautiful caterpillars (Fig. 2) are usually found in August, September and October. At first they remain in batches, usually with their heads together. In six or seven days they separate and wander over the food plant. The larvæ vary a great deal in colour. The commonest forms on hops are a pale greenish-yellow, or dull reddish, or pale brownish, with four large hairy tufts on the back and between

these deep velvety black patches, and another after the last tuft; the twelfth segment is provided with a dull red to purplish tail-like tuft pointing upwards, the whole body being covered with long hairs. A beautiful variety occurred on the apple, the form *2a* of Buckler's Plate XXXVIII., pale green, with four yellow hair-tufts, velvety black between, and a brown tail tuft; two were cinnamon yellow with similar hair tufts, and very small velvety black areas.

When mature they reach about two inches long, and pupate in a frail cocoon amongst the leaves. The pupæ are deep chestnut brown to almost black, with two paler bands on the body. They also spin upon tree trunks, poles, fences and on weeds beneath the trees.

The moth usually appears in May and June, but before this record I have found them in February.

The Dark Gothic Moth (*Nænia typica*) attacking Apples.

Damaged apple foliage and caterpillars were sent from the Dauntsey Agricultural School, at West Lavington, Wilts, on the 24th of September, from Mr. F. O. Solomon, the Headmaster, with a communication in which he says, "I have lately detected as doing considerable damage to the maiden apple trees here the caterpillars I send. I may say that the larvæ when at work outside completely skeletonize the leaves. In captivity they do not make such complete skeletons of them, though as you see, they serve the leaves very severely." The young larvæ were kindly identified for me by Mr. Richard South, as those of the Dark

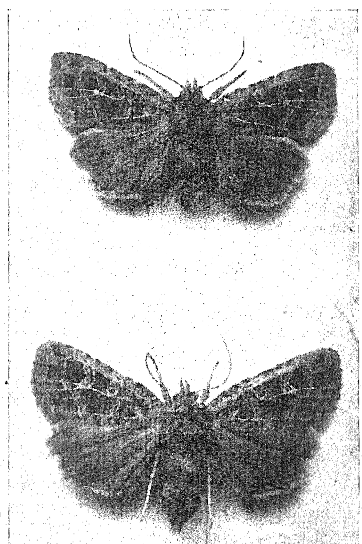


Fig. 3.
THE DARK GOTHIC MOTH (*Naenia typica*).

Gothic Moth, and he wrote that "in the young stage they feed in companies and are well in evidence, but that later they are rarely seen even on trees and low plants where they may have been in swarms."

I received the same larvæ from Enfield in 1910, skeletonizing apple foliage (Fig. 5), and found it in considerable numbers on apple at Waltham Cross in the same year. An enquiry also reached me from Sevenoaks, with specimens in 1911, and another from Esher in 1912. I was unable to identify the young larvæ, and they died in all instances, and it was not until those I received in 1913 that I was able to obtain their name.

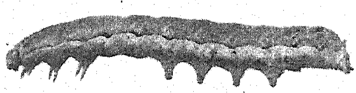


Fig. 4.
LARVA OF *Naenia typica.*

The damage although coming late in the year, may be quite serious in maiden trees, especially as the complete skeletonizing of the leaves must prevent the maturing of the wood.

The Dark Gothic Moth (*Nænia typica*) is a common insect occurring widely spread over England. It is about one-and-a-half inches in wing expanse, the fore wings are rich brown, with paler ochreous lines, an ochreous posterior border and a pale kidney shaped mark between the two narrow paler transverse lines, the hind wings are uniformly smoky grey; the thorax fluffy and brown, the abdomen greyish-brown. The adult occurs in June and July, and is found in gardens, hedgerows and small woods (Fig. 3).

The young larvæ (Fig. 5) occur in companies on the leaves, and are greyish-brown to smoky brown, with irregular paler and darker markings, sometimes with a greenish tinge. The adult larvæ (Fig. 4) is greenish-grey, with a slight rosy tint between the segments; there is a line on either side of the back,

dark grey in colour, intersected by a row of slanting whitish streaks, those on the eleventh and twelfth segments followed by a black streak; at the side is a pale, almost white line edged with black. When mature they are little over an inch long. The larvæ occur in September and later the colonies

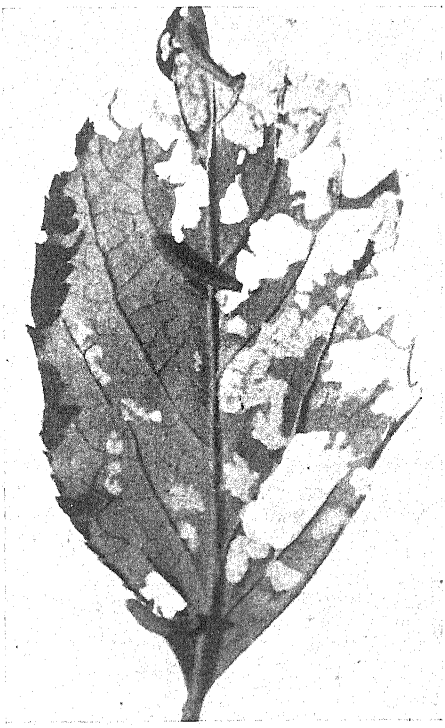


Fig. 5.
APPLE LEAF EATEN BY YOUNG DARK GOTHIC MOTH LARVÆ.

break up, and they hibernate and come out again in late winter, and mature by the end of April.

Its normal food plants are low herbs and weeds~~, such~~ as Docks and the Willow Herbs. I have also found it on small nursery alders and maples, and it is recorded here on apples. The mature larvæ (Fig. 4) are not often seen.

The Wood Leopard Moth (*Zeuzera pyrina* Fabr.).

An unusual amount of damage has been reported during the year caused by the Wood Leopard Moth (*Zeuzera pyrina* Fab.), formerly called *Zeuzera æsculi* (Plate I). In January it was sent by Mr. Vinson, from Bobbing Court Farm, near Sittingbourne, where it was attacking apples.

From Cousley Wood, Wadhurst, Sussex, larvæ were sent on March 9th, taken from Bramley Seedlings.

On April 8th specimens were sent by Mr. Tester from East Peckham, with the following note : " Kindly tell me what to do with this pest I find in my Derby trees. I got six out of one limb yesterday. I cut the small boughs off. There is a hole in the body about three feet from the bottom, which seems to be the home, and they seem to crawl up the body and eat into the boughs."

In the same month specimens were received from Captain Crane, of Oakhampton, Stourport, Worcester, who sent specimens and wrote as follows :—" Am sending a section of a branch of a Bramley Seedling planted ten years ago, half standard, attacked by what seems to me to be the Wood Leopard Moth caterpillar. It had worked its way down and right round the branch."

It was also sent by Mr. Pearson, from Brabourne, Kent, where it was attacking apple trees, and other specimens were received from Derby, Criccieth, Swanley and Esher, all in apple wood.

More recently, Mr. Harvey Bickham, of the Hill Top, Ledbury, writes me that these larvæ have been attacking plums, two he took from a twelve year planted Belle-de-Louvain and others apparently remained.

Caradrina quadripunctata attacking stored Apples.

The caterpillars of *Caradrina quadripunctata* were sent from Blairmore in September, with the following communication :—" The larvæ are infesting my fruit store. They seem to have come out of the thatch. They have eaten into apples, pears, peaches, cucumbers and marrows, in fact nearly into everything we put in the fruit store, and come in swarms."

Apples sent with the larvæ were attacked in two ways,

some were eaten from the skin inwards, large patches being gnawed away. In other the larva had eaten its way in from the base of the apple, to the centre, and there eats out a large cavity (Plate 2). One larva I kept attacked no less than six apples before it pupated, and it was more than half grown when received. The damage done to the apples is shown in the two photographs reproduced here (Plate II.).

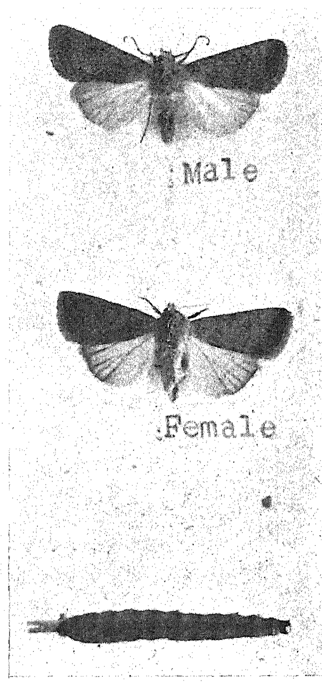


Fig. 6.
Charadrina quadripunctata AND LARVA.

The larvæ (Fig. 6.) are well known to be subject to much variation in colour, those feeding on the apples varied from pale pinkish-brown, to bright deep pink; head brown, pronotum brown; in some two narrow brown median bars on the mesonotum, the rest of the dorsum with fine irregular brown pencilling; the thoracic segments with a median, transverse row of hairs, arising from small dark tubercles; spiracles black with two small dark tubercles above and one below, from each of which arises a small hair; true legs brown, prolegs pale, with a terminal circlet of rather long brown spines; the venter of fourth, fifth, and the terminal segments with a median line of dark spots, and hairs arising from them.

The first larva to leave off feeding spun up a loose web amongst the apples on the 12th of October; the others followed in a few days, but remained in ~~the~~ larval stage.

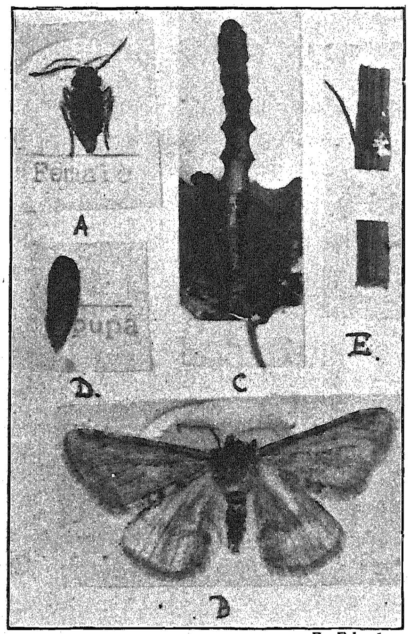
The first moth (Fig. 6) hatched in the laboratory on April 11th, others hatched on April 14th and 17th.

I have previously dealt with this species causing annoyance

in a house in Ireland (*vide* Report for year ending April 1st, 1906, pp. 103-104 (1906).

Pale Brindled Beauty Moth (*Phigalia pilosaria* Hb.).

These moths were sent on February 11th from Nottingham Lane, Eltham, with a request for information, and saying that they were being caught in the grease bands on the fruit trees.



F. Edenden.

Fig. 7.
THE PALE BRINDLED BEAUTY
(*Phigalia pilosaria*).
A. Female; B. Male; C. Larva; D. Pupa; E. Ova.

This insect (Fig. 7) is now and again enquired after by fruit growers. The wingless females get caught in the grease bands, often in considerable numbers, but it is only of local importance. The caterpillars were sent me by Mr. Wm. Bear, in May, from Hailsham, Sussex, in 1911, and many females by Mr. Fred. Smith, from Loddington, Maidstone, Kent.

I have also found many in grease bands at Wye. I have already dealt with this insect (*vide* Report for year ending September 31st, 1910, pp. 16-17, Plate II., and Report for year ending September 30th, 1911, pp. 23 and 24, Plate V.).

Specimens have also come from Little Hadham, Herts, and Bexley.

The Green Pug Moth (*Chloroclystis rectangulata* Linn.).

Quite a number of the caterpillars of the Green Pug

Moth (*Chloroclystis rectangulata* Linn.) were noticed in grease bands during the past year.

Writing from Chertsey, Surrey, Mr. J. H. Crowley sent a number of these caterpillars saying : " I am finding numbers of them caught in the Tanglefoot bands on both apple and pear trees. Unless they are of the kind which let themselves down by threads and are accidentally blown into the bands they must have very considerable muscular powers, as I find some a couple of inches from the top edge of the bands which are still tacky." Numbers were also sent from Malling, Kent, and from Worcester.

The presence of these caterpillars in grease bands has been noticed before. For several years I have found them in grease bands and in Tanglefoot, and just as Mr. Crowley remarks, many may be found close to the top of the bands. This is accounted for in two ways. Some are undoubtedly blown into the bands, for I have found them after a heavy rain storm hanging in mid air ; others for some reason or other crawl down the tree and get caught in the upper part of the bands ; the majority, however, fall to the ground, and in re-ascending the trees get caught in the lower part of the band. I have always noticed that this happens after a gale or heavy rains, and that also numbers of winter moth larvæ and Leaf Weevils fall at the same time and get caught in re-ascending.

Antithesia (*Penthina*) *pruniana Hb.* attacking Apple Trees.

On April 28th Mr. Mason, of Worcester, wrote complaining that " the stem of leaves and blossoms are being bitten off my apple trees, and I have traced the culprit enclosed. I sprayed with lime-sulphur in the winter."

The larvæ were kept and hatched out from June 20th to July 4th, into the Tortricid Moth, *Antithesia* or *Penthina pruniana* of Hubner. This very abundant species usually feeds on the plum, damson and sloe, but I have received it before from the apple, and it may also be found on the cherry and nut. The moth appears in June and July. Its wing expanse is about two-thirds of an inch. The front wings are blackish-brown at their base, then follow pale areas and a

white spot on the outer edge on the fold, the apex white, clouded with grey posterially, hind margin grey, and there are three or four dark spots near the middle of the central band; the hind wings are uniformly brownish-grey. The larvæ are greenish.

The ova hatch in late March and may be found into May. The larvæ pupate amongst the foliage. The treatment is to spray as soon as the leaves are well out in apples, as soon as the blossom has fallen in plums. Arsenate of Lead may be used, but nicotine and soap are more effectual for all the Tortrices.

Cockchafer Grubs attacking Apple Trees

A very bad attack of Chafer larvæ on apple trees took place at Crowhurst, Sussex, last year. Mr. F. N. Grant wrote on the 28th of June that he had been grubbing some two and three year planted Worcester Pearmains (three, four and five years from graft), and also some James Grieve and Stirlings on crab stock, on account of their slow and unsatisfactory growth. "In grubbing," he says, "I found that in many if not most cases the roots were badly damaged by the Cockchafer grubs, one, two or three larvæ to each tree, obviously and unmistakably eating the root bark and apparently the young rootlets which had entirely gone in many cases. It is in this case at least as serious a pest as can be imagined, as it causes the complete destruction of the trees. The grubs were on an average six to nine inches deep, and sometimes had completely ringed the root bark.

The history of this attack is as follows:—The ground, about two acres, is Wadhurst clay, which is really hard pressed sandy loam when worked up. The trees were planted in holes in turf and cultivated eight feet around; the orchard was not completely dug through until the third winter of planting; 550 trees, two-year bush trees on Paradise, except the Stirlings, which were on crab stocks. The Stirlings planted in 1910 never got away satisfactorily, due apparently to unsuitability of variety, as Lanes, Worcesters, James Grieve and Allingtons all did well. In 1913 the Worcesters, James Grieve and Beauty of Bath, planted in 1911, made a weak growth. This failure was attributed to bad cultivation and unsuitable soil and varieties. But in June, 1913, the

discovery of the root system being destroyed by Cockchafer grubs altered the matter. They were found busily at work amongst the roots."

Roughly fifty Stirlings, two-and-a-half years planted, were grubbed, twenty of which were badly damaged by Chafer larvæ.

Beauty of Bath (Paradise) two and-a-half to one-and-a-half years planted, ten grubbed ; all ruined by the larvæ.

Worcester, and James Grieve (on Paradise), one-and-a-half years' planted, twenty grubbed, all ruined by Cockchafers.

It is interesting to note that the Allingtons were quite unaffected and that many trees of the same varieties affected planted identically the same way side by side, are strong good trees. The usual depth of the grubs was six to nine inches, but injury extended considerably deeper in some cases."

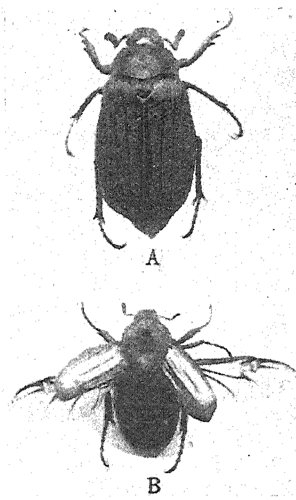


Fig. 8.

COCKCHAFERS.

A. *Melolontha vulgaris.*

B. *Rhizotrogus solstitialis.*

The specimens sent me showed the typical Chafer damage seen often in young forest trees. Unfortunately, the larvæ were not sent, so the species cannot be given, but probably it was the Common Cockchafer (*Melolontha vulgaris*), which is common in that district, and which is, I find, the chief species attacking the roots of young oaks, ash and elm. Not only do these white grubs eat the finer roots, but they even gnaw away the bark of the main roots. As they will feed right through the winter and for two years, the damage which they may do is often very great.

Melolontha larvæ were also sent me from ~~Shropshire~~, attacking the roots of currants and strawberries.

Fortunately these pests are easily destroyed in the soil by a single application of Vaporite.

Mustard Blossom Beetles in Apple Blossom.

Mr. Diggle, of Outwell, Wisbech, Cambs., wrote complaining of the damage done by the Mustard Blossom Beetles (*Meligethes* spp.) to his apple blossom. "They are very active," he says, "in fact most destructive, for once they start working at the blossom, the apple loses its power, the blossom turns brown and eventually the apple falls."

Several species of Blossom Beetles belonging to the genus *Meligethes* have now been observed to attack apple and pear blossom. They do a vast amount of damage in some years, not only by eating the petals, but all parts of the flowers. (Plate III.).

They may work alone or in conjunction with the Leaf or *Phyllobius* Weevils, and the Raspberry Beetle. When numbers occur it is certainly advisable to spray with arsenate of lead, even at the risk of killing many bees; if not, the major part of the crop will be lost.

Jarring has not proved effectual in dealing with these blossom beetles, as they get into crevices, etc., of the blossoms, and are with difficulty shaken out.

Otiorhynchus Weevils on Apples, Plums, etc.

The Raspberry Weevil (*Otiorhynchus picipes*) seems to have become a permanent apple pest, and was very active during the past year.

Writing on May 23rd, Mr. W. Luck, of Outwell Road, Wisbech, said: "I have a bed of maiden apple trees and something is working them, like the enclosed pieces sent, the attack always starts from the top. I am afraid it will spoil the trees." The insects proved to be the Clay-coloured or Raspberry Weevil (*Otiorhynchus picipes*) and the Red Legged Weevil (*O. tenebricosus*). On the 26th of the same month specimens were sent by Messrs. Jackman & Sons, of Woking, Surrey, saying that they had been troubled the last few seasons with (enclosed) weevils. They come about April and stay about a month, and then

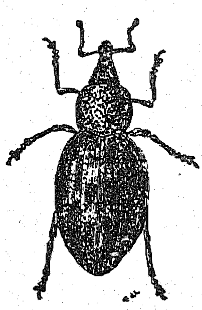


Fig. 9.
Otiorhynchus tenebricosus. x 3.

disappear, and during the time they are with us they eat the buds of plum trees, and of such trees as planes, oaks, elms and sycamores."

These beetles (Figs. 9 and 10A) are now constantly being enquired after on account of this form of damage. It is no unusual thing for them to eat out every bud and most of the rind of fresh grafts, and they may do this for some weeks, the damage being always done at night. During the day the beetles hide in the soil or under anything lying on the soil in a torpid condition. As they appear to hatch out of the soil over a period of some weeks, they are very difficult to deal with. Great numbers may be caught by trapping, by placing pieces of sacking beneath the trees; here the beetles shelter by day, and may be collected by hand. This means, owing to fresh specimens coming from the soil every

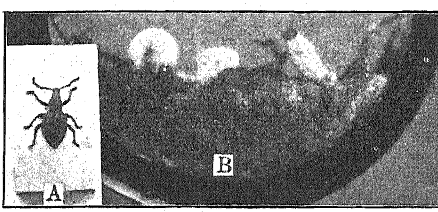


Fig. 10.
Otiorhynchus picipes A. and larvæ B.

day, a daily task, and it will be found cheaper in the end to band each tree in the attacked area with a three-inch band of Tanglefoot, which on young grafted trees should be put on paper.

Spraying with arsenate of lead was found to kill them, but several applications would be necessary.

It may be the great increase of this Clay Coloured Weevil during the last four years that accounts for its being so frequently found in starlings. This bird must have a very great effect in some districts in keeping the numbers of this destructive insect down.

Leaf Weevils (*Phyllobius* spp.).

The damage done by the Leaf Weevils, for some years discredited by fruit growers, is gradually becoming to be

recognized, and the sooner so the better. The name Leaf Weevil, which has been given to them is partly, no doubt, to blame, for the harm done to the actual foliage is small, compared to the harm done to buds and the small leaves of young grafted plants and even to their wood. Moreover they will attack the blossom to no mean extent, as shown by the following letter sent me on May 7th from Messrs. Caleb Lee & Sons., of Crockenhill, Swanley, Kent: "I am forwarding you some specimens of a brown weevil which is doing considerable damage to the apple blossom. Last year the attack was so bad that we had to spray with arsenate of lead, *and it was most effective, killing the majority of them.* I shall be very glad if you can tell us the name of the insect. It was in such large quantities last year that it attacked both the blossom and the leaf, but so far I have not found any damage except to the blossom this season. Last year we placed sacks under the trees to make sure we had killed them, and found a great many dead on the sacks."

Fig. 11.
PHYLLOBIUS WEEVILS.
(Twice natural size).

The beetles sent by Messrs. Caleb Lee were *Phyllobius oblongus*, and their most valuable notes which I give agree exactly with those I made of a similar attack on pear blossom. The trees were sprayed with arsenate of lead (Swift's), when in blossom, and no harm was done, unless some hive bees were killed; anyway the Weevils were killed and the blossom set, and I am sorry if I killed someone else's bees, but as they have only partial effect on pollination that will not concern the practical fruit grower to any very great extent.

On the 16th of May, Mr. Pain, of Sevenoaks, sent numbers of the same weevil which had been shaken off the apple blossoms.

"They seem to be doing a good deal of damage," he said, and later I found this to be so. From Chelsfield, Kent, Mr. Robert Foreman, of West Wood, Welt Hill, sent the same species with a note that they were very numerous in the apple blossom. They were also received from Hereford and Wisbech, and from Woking, where they were recorded working in a similar fashion. More recently numbers were sent by Mr. Harvey Bickham from Ledbury.

The damage done to the blossom in some places I visited was quite considerable, and in one instance the blossom was practically ruined.

The beetles are easily killed by arsenate of lead, but if some people object to poison the bees then this method cannot be employed. All that can then be done is to jar the trees, after having banded them with Tanglefoot; for I find that although some of these Phyllobius beetles fly readily, the majority crawl back up the trees and get caught in the sticky bands, but this method is not nearly so satisfactory as spraying with lead arsenate.

Black Fly (*Aphis rumicis* Linnæus) **attacking Apples.**

On the 11th of July, I received a number of Aphides from the Research Institution at Long Ashton, Bristol, from apples. They were supposed to be Koch's *Aphis chaerophilii*, but an examination showed them to be the Common Black Fly of the Bean, Mangold, Poppy and Euonymus, the *Aphis rumicis* of Linnæus. The same Aphides were sent me from South Devon on apple trees, and two strong colonies were found at Borough Green in the same month on "maiden" trees.

Thus another food plant has to be added to the already long one of this dolphin. (*Vide* article on The Aphides attacking Mangold and wild Chenopodiaceæ. Journ. Board Agri., XIX., pp. 467-476, pl. ii., fig. 1, 1912, and African Aphididæ Bulletin of Entomological Research, IV., p. 329, 1914, F. V. Theobald.)

Bugs (*Capsidæ*) **attacking Apples.**

From Wickham Market damaged apple fruitlets were sent on May 27th, together with the insects found to be attacking them.

These proved to be two species of Bugs, namely *Atractotomus mali*, and a few *Psallus ambiguus*. The trees had been washed two or three times with Abol fruit wash.

On June 3rd I also received *Atractotomus mali* from Messrs. Caleb Lee & Sons, of Crockenhill, Swanley, who wrote saying: "We find the green and dark bugs on the apple trees together, where a good deal of damage was being done. The dark bugs act in just the same manner as the green ones,

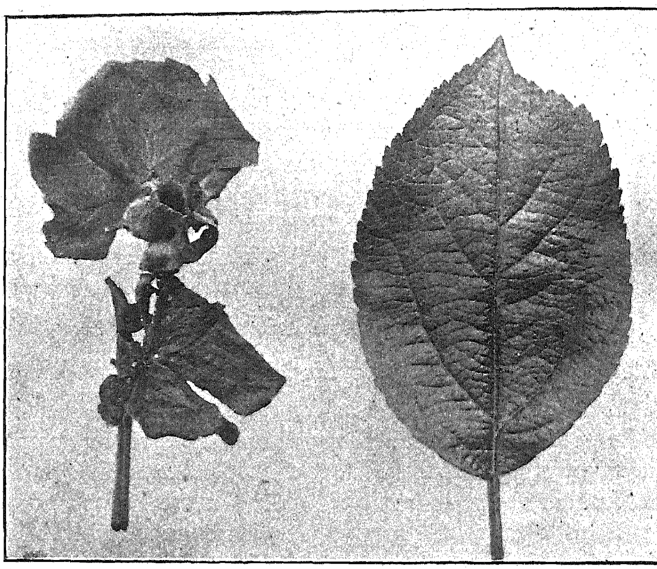


Fig. 12.
Normal Apple Leaf and one damaged by Bugs. Very similar damage is done by *Collembola* (*Sminthurus luteus*).

running fast, hiding and dropping, and even flying on being disturbed. Many of the green bugs have by now developed wings and are leaving the trees."

The *Atractotomus mali* was also received again from Hereford and from South Devon, attacking young apples.

There is no doubt that this is one of the common bugs affecting apples in this country in conjunction with *Psallus ambiguus*, *Plesiocoris rugicollis* and *Orthotylus marginalis*. At the same time it occurred in fair numbers amongst the

apples on the College Farm, but no damage could be traced to it on the fruit, but it had prominently attacked the young foliage (Fig. 12).

I also found *Atractotomus mali* in Mr. Pain's fruit plantations at Sevenoaks in July, 1913, but not in sufficient numbers to do any appreciable harm. Messrs. Caleb Lee & Sons wrote on March 14th that in the previous year's attack they had killed great numbers with Nico. and Pterokyll spray fluids.

Considerable damage was done to apples by green bug (*Orthotylus marginalis*) at Ramsgate on Mr. Steer's farm, the fruit that matured and grew out being badly disfigured by their punctures, in a very similar way to the fruit I saw in Worcestershire some few years ago.

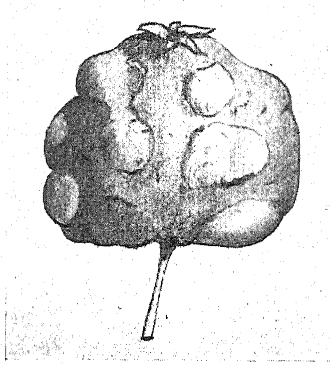


Fig. 13.
APPLE DAMAGED BY *Capsidæ*.

Similar damage to the shoots and leaves was also sent from the Midland Agricultural and Dairy College with the following note: "The disease first appeared three years ago, Bismarks being first affected. Last year most other varieties showed traces of the disease and this year some are very badly attacked indeed."

The effect of these bugs is most marked on foliage (Fig. 12 and Plate IV.) and fruit (Fig. 13). Dr. W. M. Schoyen figures* a similar attack in Denmark.

There is no doubt this Bug Pest can be controlled by spraying just when the blossom trusses are beginning to expand if Paraffin Emulsion of the ordinary strength is used, plus ½ oz. of nicotine to every ten gallons of the emulsion. This is somewhat expensive, but it has to be done if one wishes to save an often complete failure of the crop, at least a saleable crop. MacDougall's Katakilla also speedily kills these bugs.

* Ukeskrift for Landbruk, No. 13, p. 204, 1914. Kristiania. The fruit from Ramsgate and Worcester was exactly the same as this.

Lygus pabulinus also attacks the apples in Norway (Schoyen), and in Sweden (Tullgren).

Woolly Aphis cleared by "Tanglefoot" Bands, etc.

The following letter from Mr. W. Turner, of Erith, is of interest as it shows how, when the ground form of the Woolly Aphis is present, the disease may be checked by banding with Tanglefoot. "We have about 100 Cox's trees on gravelly soil, about eight years old. Three summers ago the trees were covered like snow from top to bottom with Woolly Aphis. We sprayed and killed the biggest part of them. But still it came. In October of the same year I banded the trees with Tanglefoot, and in the following summer not a bit of blight appeared. On looking at the bands I found them one mass of Woolly Aphis from the ground right into the bands, thus proving that they had come from the roots, and what a good trap Tanglefoot is if left on. The Woolly Aphis likes all soft-wooded sorts."

Colonel Honeyball* also wrote me that he had found the Woolly Aphis in the bands, and also other growers, thus bearing out the results I obtained in 1911 and 1912. There is no doubt from observations and reports sent in from all over England that there is not only a vast amount of ground form, but a periodic migration, and that much can be done to prevent this pest, so difficult a one to deal with, by banding.

A large amount of information concerning this pest is held over until I can show more definitely that it does or does not pass the same life cycle in this country that Miss Edith Patch has shown in America, *viz.*, that it winters on the elm and there causes the leaf curling, so common on our elm trees caused by *Schizoneura ulmi*, which so far has been definitely shown in Europe to give rise not to Woolly Aphis on the apple, but to the Currant Root Louse, the *Schizoneura fodiens* of Buckton.

Possibly another species of *Schizoneura* may occur on the elms in this country, but it has not so far been found. Moreover, when a winged brood of *Eriosoma lanigera* does occur with us, and it is very rare, it occurs in July, certainly not in the autumn, when none can ever be found.

* *Vide* last Report, p. 25.

Two communications only are given, received this year, as follows :—

On February 1st, 1913, Mr. S. C. Gough, of the Board of Agriculture, sent me some pear wood from Denham, Bucks, from a tree which was literally covered with this Aphis, and which had persisted all the winter on the wood close to the ground in greatest numbers, and also below ground. The wood was swollen and distorted to a great extent. I have never seen any Aphis so densely packed as in this case. They presented a rather more greenish look than is usual for *lanigera*, and were not so mealy, and at first I thought they might be a distinct species, but on transferring some to apple shoots they soon assumed the normal appearance.

I still have a colony of this Aphis, which has not produced any winged brood.

The other case of Woolly Aphis I wish to refer to here came from Merton, Middlesex, the specimens sent me by Mr. Williamson, of the John Innes Institute, were taken in numbers on the hawthorn hedges there.

These were kept alive, and as the shoots dried up they readily passed on to some fresh apple shoots placed by them. Altogether some 250 communications dealing with this insect have been received during the year, which will be referred to in a final report on this subject.

Mussel Scale (*Lepidosaphæs ulmi* Linn.).

Several enquiries concerning this common scale insect have been received.

A bad attack was reported from Worcester, another from Kirkdale, Stourport, where Cox's Orange Pippins were becoming badly infested. Several communications were received from the Exeter district, and a further attack on young trees was reported from Widdington, near Newport, Essex. It was also sent in as being very harmful from Burpham, Guildford, and from Brockham, Robertsbridge, where some Cox's were covered with it. This variety of apple seems more harmed by it than any other.

A series of experiments with this Scale insect in regard to the effect of Lime-Sulphur as a winter wash, are given on

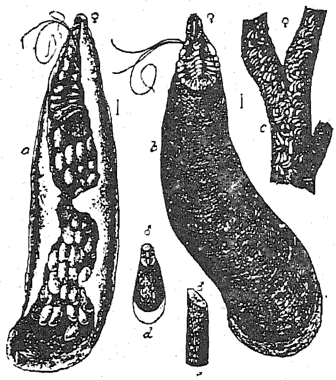


Fig. 14.—*a*, female scale, from below, showing eggs; *b*, same from above,—greatly enlarged; *c*, female scales; *d*, male scale enlarged; *e*, male scales on twig—natural size. (From—U.S. Year-book, Dept. Agr).

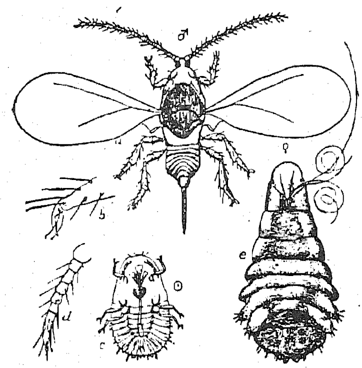


Fig. 15.—*a*, adult male; *b*, foot of same; *c*, young larva; *d*, antenna of same; *e*, adult female, taken from scale—all greatly enlarged. (From U.S. Year-book, Dept. Agri.)

page 255 etc., and also reference to its occurrence on Currants and Gooseberries on page 229.

CURRANT PESTS.

The Currant Shoot Moth (*Incurvaria capitella* Clerck).

An attack of this well-known but somewhat local pest was reported by Mr. John Riley, from Putley Court, Hereford. One patch of black currants alongside a wood was damaged considerably. Mr. Riley wrote concerning this attack in April. Another enquiry was received during the same month from Mr. Harvey Bickham, of the Hilltop, Ledbury, who wrote : "that at present the damage to the Black Currant buds is infinitesimal, but it looks as if the insect would increase and do serious damage. A single grub seems to eat the hearts out of a good many buds."

It attacks all varieties of currants, and not only damages the buds as described by Mr. Bickham, but tunnels up the top shoots, which flag and die. I have recorded this insect*

* "The Insect and Allied Pests of Fruit," p. 213, 1909.

from Kent, Worcestershire, Gloucestershire, Surrey, Cambridge, as a pest, and the moth is recorded from Bristol, Middlesex, Manchester, Scarborough, Kingsbury, etc. It seems to be widely spread over the South and Midlands and the West, and becomes rare in the North. I do not know of it from Scotland. The moth appears in May and early June, and lays her eggs in the young fruit, where the larvæ pass their early stages. By July they have left the fruit and spin up cocoons under the rind and remain there till next spring, when they enter the buds and shoots.

The treatment is winter spraying with caustic soda and handpicking the flagging shoots in spring before the moths emerge.

Green Bugs (*Capsidæ*) Damaging Currants.

In June Mr. Harvey Bickham wrote from Ledbury, complaining of damage done to his black currants, "the green, easily squashed, agile, shy insects," he says, "are becoming a serious nuisance. They puncture the top leaves of the current year's shoots to such an extent that in some instances the shoot stops growing and becomes nettle-headed (Plate V.). It is also a most noticeable fact that the currant blossoms have failed where the bushes show damage to the foliage."

Damage by Green Bugs (*Orthotylus marginalis*) was again reported in September. Mr. Harvey Bickham, who wrote at the end of September, stated that a patch of young black currants have been very badly attacked by the green bug this last summer, so badly that they have all become nettle-headed and nettle-leaved.

From observations made during the past year it does not seem that a large number of these hemiptera-heteroptera need be on a bush to do a considerable amount of damage. A single nymph was watched, continually puncturing new spots on the tender young leaves, and as these opened out, ragged patches became visible of a more elongated form than those traced to the small yellow spring tails (*Smynthurus luteus*). The nettle-headed appearance of the shoots and the nettle-like appearance of the leaves pointed out by Mr. Harvey Bickham, is undoubtedly due to this insect, if we see the small holes in the leaves and distinct scars on the shoots,

This must not be confused with the curious appearance in black currants, known as "Bucking," or "going wild," the cause of which is unknown.

At present we do not know how the *Orthotylus marginalis* passes the winter, or how it lays its eggs.

That this and possibly other allied bugs do a vast amount of harm to currants is now an established fact.

Fortunately, MacDougall's "Katakilla" speedily destroys them. Mr. Harvey Bickham writes me, recently, that he has tried this, and that the bugs were found all dead under the bushes a few hours after spraying.

GOOSEBERRY PESTS.

The Gooseberry Gall Midge (*Rhopalomyia grossulariæ*). and *Eriophyes ribis* Nalepa in Red Currants.

Two curious galled samples of gooseberry shoots have been received during the year. One was sent by Mr. C. B. Saunders of the Royal Agricultural College, Cirencester, in March, a single bush there being a mass of the curious galls, very similar to those shown in the accompanying photograph (Plate VI.).

In 1901 I found this curious galled appearance on gooseberries at Old Road, Silver Hill, Hastings, the seat of the late Captain Woodruffe, R.N., some dozen bushes being badly affected, and these in two years were so covered with the galled growths that they were burnt. I could not then find anything but a few Cecid larvæ, as a rule one in every other gall, and thus thought they thad no connection with this very sporadic and somewhat rare disease. Since I received the specimens from Mr. Saunders, in which were also one or two Cecid larvæ, I find an exactly similar disease occurs in America, due to a Cecid which has been described by Felt as *Rhopalomyia grossulariæ*, and I see no reason to doubt that the species is the same, although I have not been able so far to hatch out the fly. It also appears to be a rare disease in America.

One would expect from the galls to see any number of parasites. In fresh growth I found only one larva in each galled mass, or in some cases a pupa.

This is what occurs in America. The Cecid larva attacks the terminal bud of a spur or branch, and lives there and destroys it. The buds in which I found the Cecid were somewhat abnormal, and brown, the scales being flared open Houser* describes the American attack as follows :—The plant is injured by the insect during the larval stage in the terminal buds of spurs and branches, causing the bud to become abnormal both in size and structure. The bud scales increase greatly in numbers and size and lying closely upon another form a gall somewhat resembling in miniature the pine-cone willow galls, so commonly encountered upon the tips of willow twigs."

This answers somewhat to what I observed at Hastings.

The result is that the damaged bud develops secondary buds in numbers and some of them may be infested and the result is more buds shoot out and the curious gall-like masses arise.

Now and then some buds grow away and a few thin shoots result, but the bush is usually doomed. Whether this is the same as the disease in America yet remains to be proved, but the appearances are the same and the presence of Cecid larvæ points very strongly to this conclusion. Those who come across this rare disease should follow it out on the bushes and for reference I give the following papers dealing with the American attack :—

1. The Gooseberry Gall Midge or Bud Deformer (*Rhopalomyia grossulariæ* Felt). Journal of Economic Entomology, Vol. 5, pp. 180-184, Plate 6. J. S. Houser.
2. Hosts and Galls of American Gall Midges. Journal Economic Entomology, Vol. 4, p. 468. E.P. Felt.
3. Galls on Gooseberries. Thirteenth Report of the State Entomologist, 1913, p. 204.

A very similar appearance (Plate VI.) now and then occurs in red currants, and which I figured in my last work on Fruit Pests,† and in which I found many Eriophyid Mites (*Eriophyes ribis*) which are undoubtedly the cause of these galls, formed by numbers of secondary buds arising at the

* "Journal Economic Entomology," V., p. 189.

† "The Insect and Allied Pests of Fruit," p. 240, Fig. 180, 1908.

base of the damaged one. A specimen of this disease was recently sent me by Mr. Fowler, from Canterbury, and I again found *Eriophyes ribis* present. To be sure the mites were originally sent to Dr. Nalepa of Vienna, who definitely stated that they were the common *Eriophyes ribis*.

Gooseberry Sawfly (*Nematus ribesii* Cam.).

Very few complaints reached me in 1913 concerning the Gooseberry Sawfly, and comparatively few were observed.

In Devon it, however, appeared in considerable numbers, especially in South Devon, several enquiries from widely separate places came to hand.

One only is worth recording, namely an attack at Captain Chancellor's at Harpford, Ottery St. Mary. Here the larvæ had pretty well cleared the gooseberries of their leaves and soft soap paraffin emulsion was tried against them. Captain Chancellor found that this had not the least effect, whereas Swift's arsenate of lead paste cleared them all off in a few days.

Having an attack on two bushes in my garden, I tried with paraffin jelly on one bush, nicotine wash on the other. On both there were about 150 larvæ. With the paraffin jelly seventy dead ones were found on the third day; the rest, about eighty, survived. Those upon the nicotine-sprayed bush were all dead on the third day, many on the second.

It appears that the amount of paraffin used is not sufficient for a stomach poison, and it is only in certain conditions, such as when the larvæ have a soft skin after moulting that it affects them externally. Hence it cannot be recommended as a certain remedy for this gooseberry and currant pest. The same applies to soap and quassia which kills at one time and not at another.

Brown Scale (*Lecanium persicae* v. *sarothamni* Douglas).

A very bad attack of Brown Scale (*Lecanium persicae*, var. *sarothamni*) (Fig. 16) was reported by Mr. Harvey Bickham, of Ledbury, both on gooseberries and black currants.

Another bad attack was mentioned at East Malling by Mr. Roberts.

It was also complained about by Mr. Wm. Chambers, of Southfleet, Gravesend, and several others.

Fig. 16.
BROWN CURRANT SCALE
(enlarged).

There is no doubt that this Coccid has increased very much in recent years in Kent, Herefordshire and Worcestershire, to such an extent that it is of annual occurrence to have not only complaints as to its presence on the bushes in large numbers, both gooseberries and black currants, but also of the damage it does to the fruit, materially lessening its market value. This is inexcusable, for it is an insect that can well be kept down by winter spraying. For this purpose the normal lime and sulphur wash is perhaps best, and then next comes caustic soda. If the bushes are clean the former is certainly best, as it has a greater Scalicide value than caustic soda, but does not clean the bushes nearly as well.

Mussel Scale (*Lepidosaphæs ulmi* Linn.) **on Gooseberries.**

There has been a decided increase of late of Mussel Scale (*Lepidosaphæs ulmi*) on gooseberries in the South of England. This Coccid is well known to now and then attack the currant, and sometimes the gooseberry, but not as far as I am aware to do any appreciable damage. Two bad attacks of it were reported in 1913, one at Chart Sutton, Maidstone, where Lancaster Lads were becoming " badly affected," and the other case was mentioned to me by Mr. Lewis Levy, of Borden Hall, by Sittingbourne, who wrote that the Mussel Scale was not only increasing on his young apple trees, but was invading to a considerable extent the gooseberries.

Another case on currants was sent from Charterhouse, Godalming, the bushes being coated with Mussel Scale, many of which were and had been parasitised. Judging from the specimens sent the bushes were in a bad way from the attack of this Coccid; a few Brown Scale (*L. persicæ*) were also present.

A heavy spraying with Woburn Winter Wash, or plain caustic soda is recommended for this disease.

PLUM PESTS.

The Plum Leaf Sawfly (*Cladius padi* Linn.).

This is by no means a common fruit enemy, but it was enquired after in June by Mr. G. D. Lake, of Mortimer, Berks, who wrote saying, "I am sending you Sawfly grubs found on early Orleans plums on a south wall."

I referred to damage caused by the larvæ of this sawfly in 1905,* and again in 1909.† This leaf-eating plum Sawfly may do considerable damage when very abundant, but although widely distributed it is not apparently often so.

It feeds on the under surface of the leaves and the upper epidermis is left intact when young, but later it eats holes right through the leaves. The larvæ when mature are greyish-green, or green with almost white sides, the last two apical segments, and the head pale dull orange brown, with pale orange spots and a prominent black mark at the back of the head; some sent by Mr. Lake had the head all black. They live three weeks and pupate in the soil. The pupal stage lasts nine to twelve days. The first brood of sawflies occurs in early May, the second in mid June and then lay ova which produce a second brood of larvæ, from which a third brood of flies may appear in September, and their larvæ on maturing fall to the ground and remain there all the winter. They are easily killed by arsenate of lead.

The Prune Fruit Sawfly (*Hoplocampa fulvicornis* Klug).

Mr. A. W. Rymer Roberts, of Windermere, wrote concerning the life-history of the Sawfly known as *Hoplocampa*

* Report on Economic Zoology for year ending April 1st, 1905, pp. 18-21.

† "The Insect and Allied Pests of Fruit," pp. 372-376.

fulvicornis of Klug, and which is popularly called in the South and Midlands the Plum sawfly.

In the Windermere district it does a great deal of harm to the Damson crop, which is the principal fruit of the county. It is undoubtedly on the increase. I can remember looking upon it as a very scarce insect ten years ago. Now one can find it in almost all districts where plums are grown, and I have found it in plenty amongst wild plums in Devon.

Unfortunately, like the Apple Fruit Sawfly, there can be no remedy, and at present preventive measures do not seem of any avail.

The Shot Borer Beetle (*Xyleborus dispar* Fabr.).

Mr. Oswald Ellis, of Bramley Fruit Farms, near Guildford, wrote on the 8th of July, saying: "I am sending you a piece of stem of a Monarch Plum tree, killed by Shot Borer Beetles. I have lost at least thirty young trees this year. What I want to know is whether the beetles which exist in great numbers in the stakes (of chestnut) with which the young trees have been supported are caused by the same pest, and whether they have infested the plum trees. The stakes have been stored prior to use in a barn. I notice that wherever a tree has been affected, the stake has also been attacked, and the stakes of unattacked trees are quite free."

I have never heard of this taking place before, but it would not be surprising as the Shot Borer (*Xyleborus dispar*) is well known to attack beech, elm, alder, chestnut, and hawthorn.

It was clearly evident from the specimens sent, however, that infection had not originated in that way, as the tunnelling in the chestnut was different. It would be advisable, nevertheless, to dress all stakes with creasote before using them in districts where the *Xyleborus* is plentiful, and to paint the trees with a mixture of clay and arsenate of lead, when attacked. The chestnut stakes in this case had evidently been attacked since they were dead.

This pest was also sent in February by Mr. Selby Smith from Barming, with a note that three apple trees, all Worcesters, were full of the borers and dead. He wrote:

"I cannot account for the death of these trees, and wonder if by any chance these borers are the cause."

When they once get into a tree they are very difficult to deal with. The reader is referred to the section dealing with manures as a means of combating insect pests (page 248) where the benefit of manuring trees for this particular pest is referred to.

RASPBERRY PESTS.

The Raspberry Cane Borer (*Phorbia* sp. ?).

Several more cases of the curious attack on raspberry and loganberry referred to in my last report (pp. 44-46) have been brought to my notice.

So far all one can say is that the fly is a species of *Phorbia.* It was sent to the British Museum and all the information one could obtain was that the fly was a *Phorbia.* Mr. F. W. Edwards, an expert on British Diptera there, says " It seems allied to *P. pudica* Rondani."

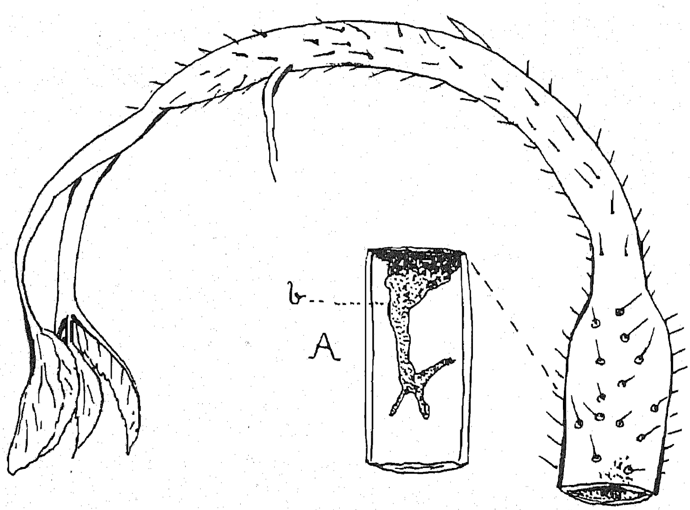


Fig. 17.
RASPBERRY SHOOT ATTACKED BY A *Phorbia* MAGGOT.
A.—Section showing tunnel.

Specimens of the damage (Fig. 17) and a few larvæ were received on June 11th from Mr. J. Mason, of Worcester, and again on August 11th. Later Mr. Mason sent an account of the indirect damage caused by the larvæ of this fly. Where the insect attacked the branches of the old established plants that stem died off and the next lower shoot grew on strongly and the plant was practically unaffected by the injury. "Whereas in the transplanted plants," writes Mr. Mason, "the old injured leaders stopped growing and gave off side shoots like those I send." All affected tips (*vide* Plate VII.) should be cut off and burnt as soon as noticed.

From specimens of damaged canes sent me in 1913, I hatched out the fly on May 1st, 1914; a photograph of which is given here.

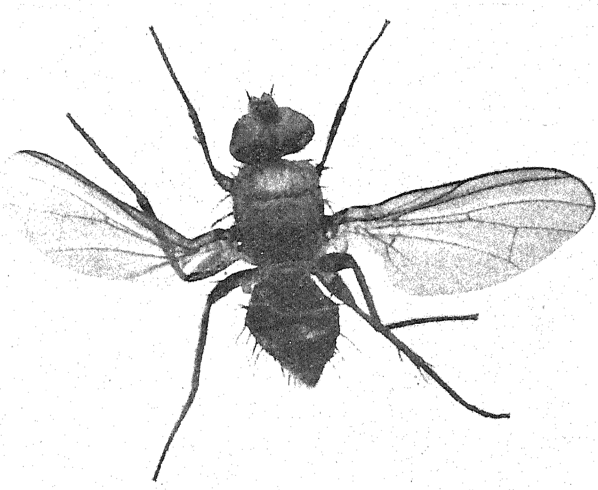


Fig. 18.

THE RASPBERRY CANE FLY (*Phorbia* sp.) × 6.

The Raspberry Beetle (*Byturus tomentosus* Fabr.).

This beetle still defies all treatment and in loganberries it becomes gradually worse. It was sent on August 1st from Wansfell, Windermere, where it was attacking loganberries. As far as I am aware this is a new locality.

I also found it in the logans at Mr. Pain's farm at Sevenoaks, in 1913.

Mr. Ivo Neame wrote in July that he had a most virulent attack in his logans at Chilham, almost every berry contained a bug, and the crop has been practically ruined. Curiously enough the raspberry plantation about a furlong from the logans was almost free, and contained less bug than last year.

Quite a number of growers have written me saying that unless a preventive can be found for this pest, the cultivation of the loganberry must go under.

With the exception of jarring and dipping the tops into tins of paraffin emulsion, there is no means of getting the up hand of this beetle. All sprayings and dustings have signally failed, chiefly because the beetles actually eat very little and thus cannot be poisoned, and the pyralin, nocotine and other powders do not reach a very large number which work their way into the partially opened buds, and so are protected. Methods of cultivation for their destruction during the winter have also yielded negative results. The beetle we also find feeding on the Bramble, yet we find but very few larvæ even in the earliest blackberries, in fact only once have I done so, in South Devon. The blackberry is extremely unlikely to be its normal host plant.

The question has therefore been raised by several growers as to whether the various cultivated blackberries are subject to the attack in the same way that the loganberry is. So far I have never found the larvæ of this beetle in any cultivated blackberry, and as I say only once in the wild blackberry.

It is quite likely that they will prove to be free from the ravages of this beetle larva, owing to their flowering so much later and consequently the beetles would have died off before any blossom was ready for them to oviposit in.

The question to settle is are there any varieties of the cultivated blackberry which would pay to grow on a large scale to take the place of the loganberry as a jam producer? Mr. Ivo Neame writes me that he has grown a blackberry for the last few years which gives very fair results and which has not yet been attacked, and says, "My idea coincides with yours, that they might escape owing to the late flowering."

Several further enquiries have been received during the past year concerning the effects of these beetles in apple blossoms. There is, no doubt, whatever that like the Leaf Weevils (*Phyllobius*) and the Blossom beetles (*Meligethes*), the Raspberry beetle does devour the petals and also the sexual parts of the blossoms. (Plate III.).

STRAWBERRY PESTS.

Swift Moth Larvæ attacking Strawberries, etc.

In the autumn a number of Swift Moth (Fig. 19) larvæ (*Hepialus lupulinus* Linn.) were sent from Botley, Hampshire, by a grower who was finding them in numbers in his strawberry plants. The plants were becoming red, instead of green, and on pulling up the plants, which came away at once, from six to seven of the caterpillars were found at the roots of each plant. They had eaten the roots off and so stopped the plants growing.

Swift Moth larvæ were also killing strawberries at Mr. Pain's farm at Sevenoaks.

An interesting communication in connection with this garden Swift Moth was received on June 3rd from Mr. W. H. Nicholls, of Newlands Farm, Ramsgate. He writes: "That we have had some tubs in the plantations full of spraying fluid, and we find hundreds of these moths in one of the tubs."

Exactly the same was noticed in the reservoirs for hop washes on the College Farm, in one 75 moths were taken on June 1st, 25 on the 3rd, 117 on the 4th, 14 on the 7th, and then but few were found; in a second receptacle 90 were found on the 4th, and 57 on the seventh.

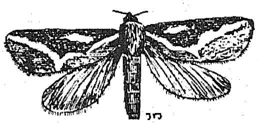


Fig. 19.
The Garden Swift Moth.

Two pails of soap and quassia left overnight in my garden on the 5th contained no less than seventeen *Hepialus lupulinus* adults.

Whether the moths are attracted by the smell of the wash, or whether they had fallen in accidentally is not known, but it may be pointed out that two barrels of plain water

standing near did not contain any of them. It thus looks as if they are attracted by the smell of the soap, and when hovering over it some adhered to their wings and so pulled them down into the fluid.

Swift Moth larvæ have been very prevalent during the past year, and the larvæ seem to have been particularly injurious to strawberries. Great numbers of moths were noticed in Thanet and near Guildford, and also in Lincolnshire.

Considerable numbers of larvæ have been found in the starlings that have been dissected, probably taken from grass land.

Aphis (*Macrosiphum fragariellum* Theobald) attacking Strawberries.

In May and June, 1904, Mr. Harvey Bickham suffered from a severe attack of Aphis in his strawberries at the Hill Top, Ledbury, Hereford.* In April, 1913, he wrote again, saying: "I now find in a three-year planted field of Stirlings a large amount of Aphis, quite sufficient to produce a serious outbreak later on. The Aphis appears to be fairly general all over the plantation of about fifty acres, but I am accustomed to a certain amount each year. The pest is most numerous in the stools where the foliage is tucked up. My past experience is that they have a bad effect on the plants which throw smaller sized fruit and thus a diminished yield."

The species at Ledbury was *Macrosiphum fragariellum* Theobald, which seems to live permanently on the strawberry. An account of this has been given in my report for the year ending April 1st, 1905,* and also in the "Journal of Economic Biology," Vol. VIII., No. 3, pp. 36 and 37, Fig. 37.

The other Aphides found on strawberries are *Myzus fragariae* Theobald,† which can be told by the fine delicate capitate hairs on its body, etc., and which is a serious pest under glass; *Macrosiphum Rogersii* Theobald,‡ an apparently uncommon species, and *Macrosiphum fragariae* Koch.§

* Report on Economic Zoology for year ending April 1st, 1905 p. 33-38, Figs. 16, 17, 18, 1906.

† The Entomologist, XLV. p. 223.

‡ Journ. Eco. Biol., VIII., 126, Fig. 38.

§ Die Pflanz, p. 173, Figs. 327-328,

Cauliflower Disease in Strawberries.

When mentioning this curious Eelworm disease so well described by Professor Dr. Ritsema Bos, and reproduced in some of Miss Ormerod's reports, I feel I must follow the latter's wise precept and quote the correspondent.

On May 14th I received the following letter from Messrs. King Smith, of Platt Farm, Borough Green, Kent :—" I am sending you to-day a box of Paxton Strawberry plants, and the grubs attacking it. This pest is especially bad here this year, and I should be especially obliged if you can let me have any information. We are finding here a very large number of plants going off. The damage seems to be caused by

(1) The grub enclosed ;
(2) Centipedes ;
(3) An Eelworm.

" I have been interested this year to note what a quantity of Weevil is being caught on the ' Tanglefoot ' bands, though I think many must be Leaf Weevils. The chickens, too, are eating large numbers."

The cause of the strawberries failing was due entirely to the Eelworm *Aphelenchus fragariae* Rit. Bos, the agent of the so-called Cauliflower disease in those plants. The specimens sent showed all those very marked symptoms so ably figured by Dr. Ritsema Bos. Fortunately the disease spreads but slowly and by grubbing and burning the affected plants as they appear it can easily be kept in check. The other interesting points in Messrs. King Smith's letter will be referred to again.

The Cauliflower disease, as far as I have seen is always fatal, anyway as far as fruit formation is concerned the plant is valueless, and had best at once be grubbed and burned, as no treatment is likely to prove of any value.

According to the health and variety of the plant attacked the appearance varies, in some we get a regular thick stem with a cauliflower-like tuft at the top, with a few stunted blossoms sent out in an irregular manner, in others the growth seems to cease and all one gets is a stunted plant with a small deformed flower mass in the middle, the blossoms close together and seldom bigger than a threepenny piece.

In both cases the result is the same and the Eelworm appears to be identical.

VINE PESTS.

The Vine Moth (*Batodes angustiorana* Haw.).

The caterpillars of this moth were sent from Osmaston Manor, Derby, on September 3rd, with a communication saying it was doing "a lot of damage in a late vinery. They form a web holding two or three berries together and work between them. I enclose damaged berries with the caterpillars."

The larvæ were nearly mature, and one spun up on September 6th, another on the 14th. The larvæ were pale greyish to greyish green, with small spots from which arise delicate hairs, the head was pale brown and shiny, and the legs and prolegs greyish-green. Before spinning they reach just over half an inch long. They pupated in a fine whitish cocoon of loose, irregular form, some at the edges of the box, two amongst the damaged berries. The pupa is pale yellowish brown to pale brown. The moths hatched out on October 4th. This seems unusual and may be due to the fact that they were kept in a warm laboratory.

The moth normally appears in June, July and August. The ova are laid on the twigs and hatch out in spring. The moth varies from half to two-thirds of an inch across the wings, has rich reddish-brown to reddish-ochreous fore wings with reddish brown markings as follows :—a basal patch forming an oblique streak, a reddish-brown central spot reaching nearly to the anal angle, between it and on the central band is a pale yellow costal spot; the male is more of a greyish-ochreous colour, with brown and black markings.

The caterpillars feed on a great variety of trees, including the apricot, pear and vine, and is especially harmful to the former, where they spin the leaves up into tubes, either a single leaf making a tube, or two may be spun together. In the apricot pupation usually takes place in the leaf nest.

It does not appear to be common on vines in this country, but as in the case reported here, if it does occur in any numbers

late in the year, it may do a great deal of harm, not so much by the quantity they eat, but by spoiling the bunches of fruit by gnawing a few berries and letting the juice flow and by spinning them together.

In late attacks on vines the only thing to do is to shake the larvæ out of the bunches and kill them. It is advisable after an attack to keep a watch for the first brood of larvæ and then to spray the vine with nicotine soap wash, so as to clear the pest out before they can attack the fruit.

The Vine Weevil (*Otiorhynchus sulcatus* Fabr.).

On March 12th a communication was received from Maidstone to the effect that "At this time of year when repotting our vines, the almost matured grub of the enclosed Weevil is found amongst the roots. They cause much damage. The Weevil I send has been kept in a box to develop. All the soil used to pot the vines in was burnt last year before the vines were planted, so the eggs cannot have been in that."

This Weevil proved to be *Otiorhynchus sulcatus*, which attacks the roots of very many pot plants in its maggot stage. Although the beetle itself does damage in the same way as *Otiorhynchus picipes*, it is in its larval stage that most harm is reported.

The Vine Weevil I have found as early as late January, so that it is quite possible that the beetles had oviposited in the burnt soil.

OTHER FRUIT PESTS.

Amongst other fruit pests information as to treatment, etc., has been sent concerning the following :—

1. **Big Bud** (*Eriophyes ribis* Nalepa), from Lingfield, Erith, Godalming, Haslemere, Hastings, Battle, Rye, Worthing, Botley, Ventnor, Meopham, Gravesend, Blackheath, Filey, Worcester, Hereford, Paignton, Exeter, etc., etc.

Mostly cuttings were sent to be examined for this pest, which after decreasing to some extent the last four or five years has broken out again in many districts worse than ever. Two attacks on red currants have also been reported.

2. Apple Blossom Weevil (*Anthonomus pomorum* Curtis).

An enquiry was received from Messrs. King Smith, of Platt Farm, Borough Green, asking for advice concerning the Blossom Weevil, and saying it had been very troublesome during the past year, also pointing out that many of the beetles had been caught in grease bands, and that the beetles hid during the winter in the soil at the base of the trees.

3. Apple Sucker (*Psylla mali* Forst.).

But few letters are received now concerning this pest, as most fruit-growers now know how to deal with it. It has been bad at Yalding, however, Messrs. Reader Brothers writing and saying they had suffered, and asked for the best time to spray against it. Information concerning it was also asked from Clapham, near Worthing, Sussex, where it had been doing some harm.

4. Apple Aphis (*Aphis pyri* Koch. non Boyer).

The so-called "Blue Bug," or "Leaf Curling" Apple Aphis has been very bad during the past year, numerous enquiries reaching me from Kent, Sussex, Hampshire, Worcestershire, Herefordshire, Cambridgeshire and Dorset. It was particularly bad in Kent and near Worthing in Sussex.

The so-called "Blue Bug" or Rosy Apple Aphis has been known in Europe and America for a long time as *Aphis sorbi* Kaltenbach. I find it is quite distinct from it, having black cornicles, whilst in *sorbi* they are pale. Koch described this aphis as *Aphis pyri*, but the name had been previously used by Boyer de Fonscolombe, so it must be renamed.

The Apple Aphides are being dealt with in a separate paper to be published elsewhere.

5. Currant Aphides.

From Halesworth, Suffolk, Miss Ewbank wrote in 1913 that she had suffered from a bad attack of honey dew in her black currants, variety Boskoop Giant, and asked for preventive treatment. Autumnal spraying was recommended.

6. Red Spider (*Bryobia ribis* Thomas).

Information concerning the red spider on gooseberries (*Bryobia ribis*) was asked for from West Lavington, Wiltshire and Swanwick, Southampton. The specific name of the Gooseberry Red Spider of this country does not seem to be known. According to Continental authors it is *B. pretiosa* Koch, found on ivy. The ivy and gooseberry species here appear to be distinct.*

7. Red Spider (*Tetranychus telarius* Linn.).

This acarid was enquired about from Staplehurst, where it was attacking the grapes in June when about the size of peas. They were sprayed with Lime of Sulphur 2 oz., soap 3 ozs., water ten gallons.

8. Earwigs and Wood-lice under Grease Bands.

An enquiry as to the use of Tanglefoot direct on the bark was received from Shadoxhurst, because the writer found that Earwigs, Woodlice, etc., collect in great numbers under the bands and damage the bark. There is no doubt that this does happen, and that if the bands are left on a good deal of damage may be done. However carefully the bands are tied I have found that innumerable insects collect beneath, and for this reason it is necessary to remove the bands in late spring, so as to let the moisture the insects leave behind dry up. The Tanglefoot, however, I find can be put direct on the bark except on young trees and on peach and apricot.

9. Beetle Mites or *Oribatidae.*

Great numbers of these so-called Beetle Mites have been received, and many of them kept to see if I could trace any apparent damage caused by them by putting numbers on some young trees.

A large number were received on May 6th from Mr. W. R. Nicholson, of Twyford, Berks, where they were swarming on the fruit trees.

Growers seem now pretty well convinced that these Acari

* Since this report went to press, Dr. Trägårdh, of Stockholm, tells me the specimens I sent him from ivy and gooseberry are both the same species, namely *B. pretiosa.*

are beneficial, but are still uncertain as to which are the ova of the Oribatidae and which of the Red Spiders (*Bryobia* and *Tetranychus*). The latter are much smaller than the former and occur in large dull reddish masses, hatching out in late March, when the Oribatidae are quite active.

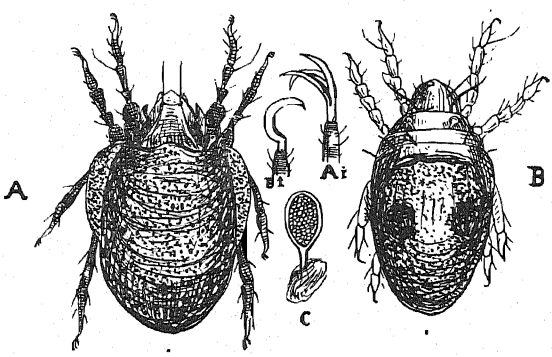


Fig. 20.
BEETLE MITES (*Oribatidae*).
A. Adult *Oribata lapidaria*; B. Nymph; C. Stigmatic organ.
Ai and Bi., Ungues.

Numerous Oribatidae from apple and plum were also received from Clapham, near Worthing, Sussex.

10. Plum Aphis (*Aphis pruni* Reau.)

A bad attack of Green Plum Aphis was recorded by Mr. J. Clarke from his plantations at Harlington, Middlesex; Staplehurst, in Kent, and in Surrey. Communications were also received from Messrs. Hammond & Co., of Brentwood, Essex, concerning this insect, in its early stages. The latest time to spray to do any good is April 6th.

11. The Pear Midge (*Diplosis pyrivora* Riley).

A large number of enquiries were received concerning this fly (Fig. 21) during the year from widely scattered localities, from Scotland to South Devon.

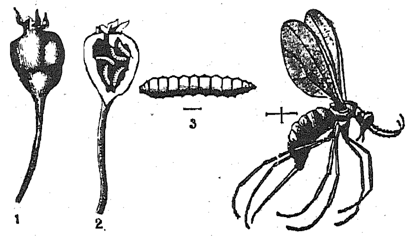


Fig. 21.

1. Pear stunted and malformed by the larva within it. 2. Section of pear with larvæ. 3. Larva, much magnified. 4. Female fly, much magnified. Lines show natural length of fly and larva.

(From U.S.A. Dept. Agriculture).

One attack at Old Malden, Surrey, was reported by Mr. Potter, of Pond Farm, in which every pear seemed to be affected, they were Williams and had a fine set of blossom. So far no satisfactory means of dealing with it is known, although some benefit is derived by keeping chickens under the infested trees or in the plantations, and many growers have reported benefit derived from spreading Kainit at the rate of five cwt. to the acre under the trees about the time the larvæ are falling.

12. Mealy Bug (*Dactylopius citri* Risso.).

The treatment of Mealy Bug (*Dactylopius citri* Risso.), (Fig. 22.c.), on vines and peaches was enquired after from

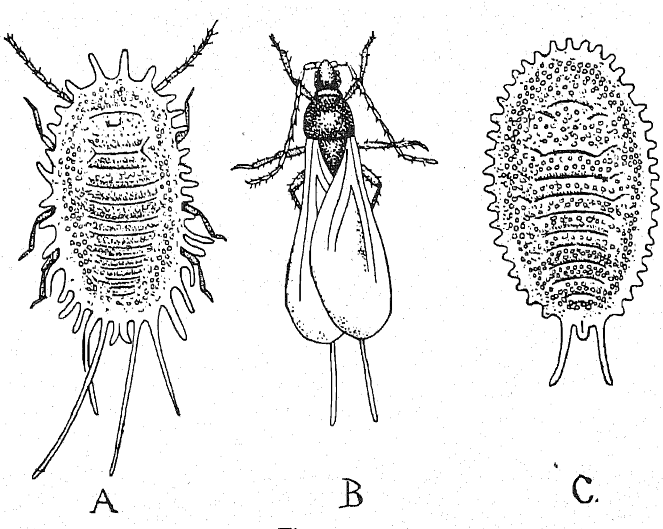


Fig. 22.

A. *Dactylopius longispinus* ; B. Male ; C. *D. citri*. (After Newstead.)

Bognor, Sussex, in March ; a note added said that no treatment so far used had been of any avail. Fumigation with hydrocyanic acid gas was recommended, as it is the only certain way of eradicating the insect.

13. Apple Leaf Sawfly (*Lygæonematus moestus* Zaddach).

Another locality has to be added for this species. On June 11th Mr. G. M. Holmes, of Sevenoaks, sent the larvæ taken by him on the leaves of a wild crab apple near Sevenoaks, which it was then stripping. They were just on the point of pupating, and commenced to do so on June 15th. They hatched out on April 12th, and continued to do so until the 20th, and oviposited on the 18th on the leaves.

14. A Tineid Moth (*Dasycera sulphurella*) bred from Apple and other Trees.

In April larvæ were sent me, taken from the bark of apple trees at Putney, by Mr. G. C. Gough. It was thought that they might be of an injurious nature. They were kept and bred out, and proved to be *Dasycera sulphurella* Fabricius.

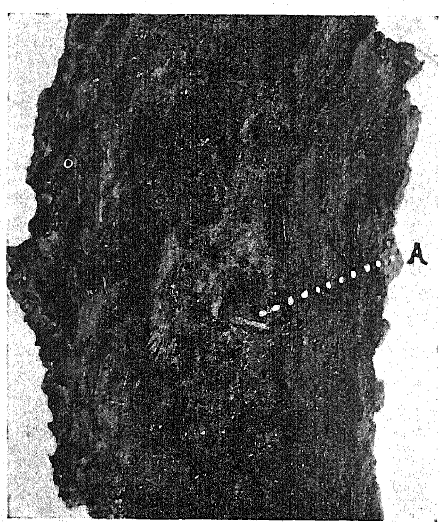


Fig. 23.
Damaged Bark and
Pupa of *Dasycera sulphurella*, A.

In February similar specimens were received from Whitstable; this time from the bark of ash and elm.

This moth is also spoken of as *Dasycera orbonella* Hb., and as *Œcophora sulphurella* Fabricius. MacDougall (Trans. Highland and Agi. Scot. Scot., 1912) records it from beech and oak. It lives as far as I have observed entirely under dead and diseased bark (Fig. 23) and often occurs in large numbers in such places and is of little economic importance to trees, but according to MacDougall it is sometimes destructive to palings. The caterpillars are dirty greyish-white to pale dull greyish-brown, with dark spots over the body and dark head and normal legs. Those sent me pupated in April, under the dead bark and emerged on April 12th to 30th.

The larvæ are extremely active and make quantities of "frass" which collects with some webbing and their cast skins and pupal cases under the bark.

Description of the Moth (Fig.24).—Fore wings black brown with a marked V-shaped yellow patch on the inner border, quite black around it, apical area with many scattered, yellowish-bronzy scales, two lines of them at the base and others scattered over the surface; hind wings yellow, black at the apex and some scattered black scales at the base; front wing fringe black; hind wing fringe long, black at the apex, rest yellow with dusky apices. Head and antennæ black; proboscis and palpi orange yellow; head with some creamy scales in front Thorax black with some yellowish scales in front and over the wing roots. Abdomen black, some segments with apical yellow scales, tail tuft black. Legs black; hind tibiæ with long yellow hairs and two prominent apical spines; tarsi black, the first three with white apices.

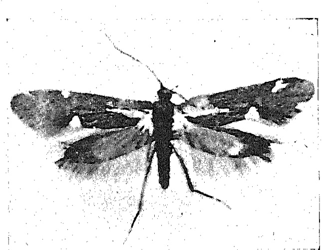


Fig. 24.
Dasycera sulphurella ADULT (x 3).

The *pupa* is shiny yellowish to pale shiny yellowish brown with dark eyes.

15. An *Aphelenchus* Disease in Pear Leaves.

In August and September I received some pear leaves that were spotted with dull brown areas. Some few leaves were all dull brown and some were becoming black.

On teasing these out in dilute glycerine, I found they contained countless eelworms, that appeared to me to be exactly the same as the *Aphelenchus olesistus* Rit. Bos.

There was no trace of any ova in the leaves or in the nematodes themselves, yet they appeared to be fully grown. In two other instances I found the same eelworm in pear leaves in Wye, but this was in the end of October and the foliage was fast decaying.

Aphides destroyed by a Fungus.

A vast amount of Apple and Currant Aphis occurred in 1913, and in some districts it looked as if the latter (*Rhopalosiphum lactucæ*, *Myzus ribis* and *Macrosiphum ribesii*) would cause almost complete loss of crop, and to no small extent the Apple Aphis also.

As early as the 4th of June I received a communication from Messrs. Caleb Lee & Sons, of Crockenhill, Swanley, Kent, enclosing a sample of black currant leaves which had been very badly attacked by Aphis. "I was thinking of spraying them," writes the correspondent, "this week, but now I find that something is killing large numbers of them off, and I wondered if you could tell me the cause. I had a similar experience two years ago, the attack then being bad and then all at once they seemed to all die off."

Writing further on the 7th, the same correspondent stated: "Again yesterday I went and made a careful examination of the black currants that have had the aphis so badly, and I find that they are still dying off very fast. There are nearly two-thirds of them dead, I should think."

The specimens sent were completely covered with the mycelium of some fungus, on several leaves not a single live aphis remained. The few live insects sent developed the disease in two or three days, and a few days later I found them dead, and covered as the others with the fungoid growth. Apparently the same fungus was attacking the Apple Aphis.

As far as I could see, exactly the same fungus was also attacking the Black Peach Aphis (*Myzus persicæ* Sulzer) to a great extent, and to a lesser extent the Green Peach Aphis (*Rhopalosiphum dianthi*), both of which were attacking peaches under glass at Rudgwick, Sussex. When I visited these peach houses in April, the Black Aphis was appearing in considerable numbers, and it was noticed that here and there large colonies were stationary, and on moving the aphides a fungoid growth was seen holding them on to the plant and the mycelia spreading up over the aphis. This vegetal parasite spread rapidly amongst this aphis and to a very large extent had cleared it off. It made but little headway, however on the *Rhopalosiphum*. In some respects the fungus growth differed from that of the currant and apple aphis and it may have been a separate species.

Later in the year (July) I found a fungus again in great profusion amongst the colonies of the Nettle Aphis (*Macrosiphum urticæ* Kalt.) at Wye, huge colonies of the apteræ being destroyed by it. In the same month I found two small colonies of the Corn Aphis (*Macrosiphum granarium* Kierby) attacked in a similar maner, the whole of each colony, which consisted of mature apteræ, being killed, the young also dead, apparently having been smothered by the mycelial growths from the females.

A similar fungus also swept off whole colonies of *Rhopalosiphum calthæ* Koch, and *Aphis rumicis*, which in some previous years I have seen completely eradicated by it.

According to Cooke ("Vegetable Wasps and Plant Worms," p. 306, 1892) aphides have no less than five entomophytes of the *Empusa* kind, which destroy them in different parts of the world, and this so effectually, that it has been proposed to utilize the fungus in order to reduce the pests in conservatories. The common Aphis Endophyte is called *Entomophthora aphidis* Hoffman.*

Thaxter found this to be a decided check to aphides in America under glass, and also to the hop aphis, and also to clover aphides at Washington.

* Hoffman, in Fresenius' "Entomophthoreæ," p. 208, Figs. 59-67, and Thaxter, "Entomophthoreæ U.S.," p. 175, Plate 18, Figs. 220-240, and Saccardo, "Sylloge," VII., No. 975.

It is common to Europe and America, and according to Thaxter attacks many genera of Aphides.

Another species is known as Fresenius' Aphis Endophyte† (*Empusa fresenii* Nowakowski). This is also common to Europe and North America. It attacks the apple aphides and others, and is quite likely the one attacking the currants, as the appearance in the same as that produced on the apple aphis.

It is to be hoped that this group of parasites will be worked out, as they undoubtedly have a very beneficent rôle, and do far more good as far as I have seen in checking aphis attack than any parasitic or predaceous insects.

The Manuring of Fruit trees, an Aid in Combating Tree Pests and Adverse Climatic Conditions.

A paper written by Hoffmann in "Deutsche Obstbau-zeitung," and reprinted (Schweiz. Zeits. für Obst.-und Weinbau, Frauenfeld, xxii. 14, pp. 218-220. 1913) deals with experiments made at Germersheim, when large numbers of plum trees had been killed by *Scolytus* and *Xyleborus*, *i.e.*, Bark Beetles, and Shot Hole Borers.

Plots of trees were manured in various ways. The results showed that plots treated with potassium phosphate had a loss of 8½ per cent, with lime only 16⅝ per cent., whereas one third of the trees which were untreated were killed by these insects. The trees were also covered with lime wash twice a year.

The greater resistance of the manured trees was probably due to the fact that their woody tissues grew more rapidly thus causing the tunnels of the beetles to close up. The effect of manures upon fruit trees is one that has not been properly dealt with, and as I pointed out in the "Insect and Allied Pests of Fruit," it is a very important one for the fruit-grower to consider.

The following has some bearing on this subject. Four old trees of my own, heavily sprayed with lime and salt, 1911, were covered with Mussel Scale, and in a generally

† Nowakowski, "Entomopthoreæ," p. 171, Plate 12, Figs. 115-125; Thaxter, "Eutomophthoreæ U.S.," p. 167, Plate 16, Figs. 106-140.

unhealthy state. Two others were left, in no worse a condition. The two last died away, but the other four, although the Mussel Scale was not killed, certainly improved next year, and are now (1914) in a comparatively healthy state, and carried a good crop of fruit in 1913. Moreover, the Mussel Scale has so far decreased that it is of no special importance.

This decrease was not due to spraying and certainly not to parasites, none of the coccids having been attacked at all.

From personal observation I can say it was not the action of the Lime Salt spray on the trees. but their after effects on the growth and the improvement of the health of the trees.

The Effect of Lime-Sulphur Spray as an Insecticide.

This spray fluid, like many other things before it, has been claimed to do all manner of marvellous things. Like others that have gone before it, the omnipotent powers gradually lose their lustre and glory as time goes on.

The question to solve is what good do such things do, for all apparently do a certain amount.

Its origin as a fruit tree wash came mainly from the fact that it was used with much success as a sheep dip for scab, etc. It is a potent and very potent factor in dealing with the San José Scale, and having been found an effective control for that fruit pest in America, it has been rushed into prominence in Britain, with the etceteras of a general panacea for all diseases. Having as little faith in a general fruit tree remedy as one has in a general human remedy, trials have been made during the last five years of the lime-sulphur wash as an insecticide. I also experimented with it many years before.

Its fungicidal value is now well established. With regards to its insecticidal value we may deal with it under three headings —

(i.) Its effects as a cleanser of trees from insect and mite hibernating quarters.

(ii.) Its effects upon hibernating insects and mites and their ova.

(iii.) Its effects upon living insects and mites in summer, both as a contact wash and stomach poison wash.

Its fungicidal value must be entirely discarded in this summary, and no personal opinion in this respect is mentioned,

although as long ago as 1889 I used lime and sulphur, under slightly different conditions, in the place of previously-used hot lime as a means of controlling Apple and Pear Scab, and Leaf Spot due to an Eriophyid mite in Walnuts, with good results for the two former. At the same time it was used against Codling Moth. The results as far as Codling Moth went were most disappointing, whilst trees coated with hot lime wash soon ceased to be troubled with that pest, the hot lime cleaning the old trees far more successfully than the lime-sulphur compound.

Early Experiments.

In 1887 the fruit orchards of apple, pear, plums and walnuts, at my home in Surrey, were put under my care, and I determined to put the old trees in order, and at first, acting under a gardener's help, I used nothing but hot lime in winter, thrown on with an ordinary garden engine. Later, in 1899, sulphur was added. The pests present were first the Codling Moth, which was very bad, not only in apple and pear but also in walnuts; then Mussel Scale on apples and pears; the Woolly Aphis on apples especially on Ribston Pippins, and a large yellow Codling, whose name I did not know; and then "Scab" on apples and pears. The only other pests were caterpillars of the Winter Moth, the females caught by tarred hay bands on the trunks of the trees, much Woolly Aphis on both apple and pear, and rooks that took the walnuts.

The results in one of my diaries in 1889 are as follows —

"January 7th.—Twelve old apple trees, six Swan's Egg Pears and two Williams sprayed with hot lime; head gardener and four men worked all day and fairly well covered the trees with a good coat, but to their cost. Attacked by Mussel Scale, Woolly Aphis, Codling Moth and Scab.

"January 27th.—Four Codlings, twenty Ribstones, one Golden Pippin, and four King Pippins sprayed with lime and sulphur for Black Spot, Woolly Aphis, Mussel Scale and Codling Moth; also two walnut trees for Codling Moth and "Spot." *

* This disease I did not know then; it is due to one of the Eriophyidæ.

"February 21st.—One large Golden Pippin, a Medlar and a Quince, sixteen large cooking apple trees sprayed with hot lime and three old trees of Ribstons with a mixture of lime and sulphur. All attacked with Mussel Scale, Codling Moth and Aphis in the previous year. Also twenty plums (Victorias) which had been badly attacked by Green Aphis and Fruit Maggot with lime and sulphur."

The trees sprayed on January 7th with hot lime bore a good crop, much cleaner of Black Spot than any untreated ones, the number of maggoty apples was very small and most of the Mussel Scale peeled off, and the ova died in consequence. The trees sprayed with a mixture of lime and sulphur January 27th were not nearly as clean of Mussel Scale, and the mixture had little or no effect in bringing off the rough bark, and so destroying the larval Codling Moths; one tree, a Ribston, had quite half the fruit maggotty. The Woolly Aphis was as bad on these trees as on any untreated ones. But Mussel Scale had later undoubtedly decreased.

The trees washed on February 21st with hot lime were far and away cleaner than those sprayed with the lime and sulphur, except that the black spot on the Apples and Quince was worse than on those sprayed with lime and sulphur.

The most marked result was in connection with the plums and gages, the trees coated with hot lime had no aphis attack, but those with lime and sulphur were as bad as in the previous year. The conclusion I came to was that hot lime was far more effectual than lime and sulphur. The mixture of lime and sulphur used was 30 lbs. of lime, 30 lbs. of Sulphur, to fifty gallons of water, the lime was merely slaked and the sulphur gradually worked into it.

In 1903 I experimented with lime-sulphur wash again, with the addition of salt, the formula used being: Lime 40 lbs., Sulphur 20 lbs., Salt 15 lbs., to fifty gallons of water.

This was tried on advice sent me from the United States Bureau of Entomology, and by Mr. Lounsbury, then Government Entomologist at the Cape of Good Hope. In this case it was tried only for Mussel Scale. The trees treated were two on the College Farm, and several at my own home, the trees were about fifteen years old, upon which the Mussel

Scale had appeared two years previously, and upon which it was rapidly increasing. Two sprayings were made, one in January, and another the end of February, as the scales covering the ova were seen not to be affected in the least by the first. These two sprayings, however, effectually cleared the trees of this pest."

The wash was then observed to have no direct effect upon the scales, nor the ova. Moreover on the treated trees the ova hatched out as usual, but earlier than I have ever known in that year, namely early in May, the usual time being June. Many live larvæ were found in May and June on all the treated trees. But later in the year many of the young on all the treated trees died off, many of the late-hatched larvæ, *i.e.*, in June, living but a few hours after hatching, some few only lived on.

Several individual trees were sprayed with the lime-sulphur alone, and with different proportions of these ingredients. It appeared that the lime and sulphur were the active agents in causing the death of some of the young, yet the salt greatly enhanced the killing power of the wash. Some trees were only washed once and the result was the same as on those washed twice.

How it acted in partly clearing these trees of Mussel Scale was not clear; it certainly did no harm to the ova, for great quantities of young emerged. It seems to have some secondary effect upon the larvæ.

In the following year two trees were treated in the same way, but with reverse results, the young maturing normally. It thus looked as if some other agent had been at work causing the death of the newly hatched young and in treating a large orchard in 1905, the lime-sulphur-salt wash was discarded.

In 1909 I tried the lime-sulphur wash again on some old trees badly infested with Mussel Scale, and it had very little effect upon them, no ova being destroyed and the young in most cases developed.

In 1913 some trees attacked by this pest were sprayed with lime-sulphur, a preparation made by Voss, others with caustic soda, others with lime and salt. In none was the Scale cleared, and only the caustic soda treated trees showed any

* Reports on Economic Zoology, pp. 39-41. S.E.A.Coll. Journal, No. 13, June, 1904.

large percentage of dead ova, but again many larvæ died off where the lime sulphur had been used.

It thus appeared that as a winter wash for Mussel Scale lime-sulphur wash has a very uncertain action, but that under certain conditions the young are destroyed soon after hatching. Its effect upon some other Scale Insects is however, very different, as will be pointed out later.

In 1911 I sprayed gooseberry bushes and currants in February, that had a great number of young Brown Scale (*Lecanium capreæ*, v. *sarothamni*) upon them, as well as quantities of the ova of the Red Spider (*Bryobia ribis*). The eggs of the Red Spider were unharmed, but it was later noticed when looking for the Red Spider that the immature *Lecania* were brown and shrivelled. Consequently in 1912 and 1913 I repeated this treatment for Brown Scale, and in every case the immature insects were killed. Two bushes side by side were sprayed, one with caustic soda, the other with lime-sulphur, whilst the caustic soda brought off all the old dead exuviæ of the insects, only 60 per cent. of the immature forms were killed; on the other hand the lime-sulphur had not removed the very noticeable dead scales, but had killed 90 per cent. of the immature insects counted on two branches, and on examining the rest of the bush I found them nearly all dead. I noticed a similar result on Messrs. King Smith's farm at Borough Green in 1912. I tried this treatment once more against caustic soda, and the result was still more defined, nearly every insect being destroyed by the lime-sulphur. It may be safely said that lime-sulphur is an active scalecide for such living scale insects, but that its effect as a winter wash for Coccids that are in the egg stage, protected by a hard "scale," such as in the Mussel Scale, that its value is decidedly uncertain. Whilst its surface effect on the scale *may* show, its power on the ova is so slight as to be negligible, and its uncertain after-effects must make us doubtful of it as an effective Mussel Scale Wash. Its after-effects are referred to later.

Such may be said in a general way of lime-sulphur as an insecticide, gathered from experiments on a single group of insects.

Let us now deal with it under the three different headings mentioned on page 249.

I.—Its Effects as a Cleaner of Trees from Insect and Mite Hibernating Quarters.

On February 5th and 7th, 1912, two apple trees, each in a row, were sprayed with lime-sulphur wash supplied to me; two with caustic soda; two with Woburn Winter Wash, and two with lime-salt wash. These were fairly young trees and had no special insects on them, but covered with green algæ. The result was most marked, caustic soda sprayed trees showing up dark, clean and bright, also the Woburn Winter wash ones; the lime salt ones well coated and white; the lime-sulphur ones much cleaner than six unsprayed ones left, but very different to those treated with caustic soda and Woburn Winter wash. A very casual glance showed which cleaned the trees best, of the caustic soda, Woburn and lime-sulphur washes.

On the 7th of March I sprayed one old tree with caustic soda, another with lime-sulphur. Both had much rough bark and moss, many cocoons of Codling Maggot and other hibernations under the scaly bark. In May one could detect little difference between the two, but by July all the bark had peeled off the tree treated with caustic soda, and none off the tree sprayed with lime-sulphur.

In the winter of 1913 I again used this wash to test its effects as a cleanser of old and young trees, and found as before it had far less effect than caustic soda. In 1914 I used again the normal lime-sulphur wash, and a lime-sulphur powder, both against caustic soda. They were far behind and in the case of the powdered lime-sulphur very far behind. In two trees I used double strength of the lime-sulphur, and it then did not clean off the green matter on young trees half as well as the caustic wash.

As a winter cleaner of young trees I am certain lime sulphur is far behind caustic soda, or hot lime and salt, and on old trees it is practically of no value for this purpose.

II.—Its Effects upon Hibernating Insects and Mites and Their Ova.

Irrespective of the cleansing power, that is in destroying foreign growths upon fruit trees, of a winter wash, one has to

consider if it has any direct effect upon the hibernating insects, mites, and their eggs.

Certain insects may be destroyed in winter by spraying, or more correctly speaking "*washing*." A mere spray, such as one would use in summer, of Bordeaux and arsenate of lead, poison as far as insects go, in winter are quite useless. One has to thoroughly drench a tree if one wishes to kill any hibernating insect in winter. Commonsense will tell any man this who has looked into the crevices of an old or young tree where the few insect hibernations such as Woolly Aphis, Codling Maggot, Thirps, young Scale, Earwigs, etc., live.

As a matter of fact with the exception of Codling Moth, of some "Scale," and some Woolly Aphis, little or no insect life is harmed by winter spraying directly. One may do good indirectly by keeping one's trees clean and so prevent favourable winter quarters, and place the summer foes at a disadvantage, or remove certain insects which, falling down later, get killed.

The effect upon Mussel Scale and Brown Scale has already been mentioned, the somewhat uncertain results upon the former make it unnecessary to refer to it at any great length. The very beneficent results on the latter make it imperative to use this lime-sulphur wash where gooseberries, currants, etc., are attacked by "Brown Scale," as a winter treatment.

The only other important insect it is certain to destroy is one that fortunately in this country is not prevalent, that is the Scurvy Bark Louse of Plums, etc. (*Aspidiotus ostrœeformis*). Only once have I had the opportunity of seeing the effect of lime-sulphur wash on this insect, and then, just as it works on the San Jose Scale, it was found to be an almost complete killer. It similarly destroyed the Rose Scale (*Aulocaspis rosæ*).

As a Winter wash for Woolly Aphis I can say nothing more except to give two small experiments.

Two pot trees, "Belle de Boskoop," which I had obtained on account of their supposed immunity against Woolly Aphis, had become after two artificial "innoculations," covered with this Aphis, in fact had become two beautiful "Museum" specimens. In December, 1913, and in February, 1914, I gave these two plants not a spraying but a thorough drenching

with lime-sulphur. On March 10th I found two large colonies under broken pieces of rind, and several in an old Aphis wound. By May there were again large colonies, not derived from the root form.

On referring to some notes made in 1912, I find that on two old trees "washed," not "sprayed," with lime-sulphur, that the Woolly Aphis was bad in the summer. If under these hard trials, which are not likely to be used in common practice, the so-called American Blight survives, lime-sulphur cannot be looked upon as of any help. Moreover, most Woolly Aphis is in the rootage during the winter.

Now with regard to the effect of this wash upon Insect and Mite eggs.

I have heard it stated that it will kill the eggs of Aphides, Psylla and Red Spider. This has been heard before of other washes. Let us look into this matter. Take first the eggs of the *Psylla*, the so-called Apple Sucker. Cut off a spur, covered with the ova, put it *in water* in December. Very few if any will hatch out. Cut another spur off in early March, put it in water, and many will hatch out. Keep them dry and none will incubate.

Do the same with spurs dipped in caustic soda, Woburn Wash, lime-salt, lime-sulphur, and you will find the same. But you will notice this, that if the spur is coated with thick lime or moderately coated, that the young Psylla cannot crawl amongst the particles of lime and die. But with the other washes the amount of foreign-matter left on the surface of the plant is so small that the majority get to the buds, but some undoubtedly are killed by the lime-sulphur.

As a means of killing the eggs of the Psylla lime-sulphur wash is as useless as any other, and it has not such bad after-effects on them that a thick lime wash has.

Many people have told me that lime-sulphur kills Aphis eggs. Anyone by means of a Coddington lens can see Aphis eggs clearly, and if one takes the trouble to look, in say early December, one will see them as all smooth, plump, shiny, black ova. Look again in late January, and you will find very many not the same; they are shrivelled and unhealthy. In one case I remember in 1904, nearly every egg had this appearance. The trees had not been sprayed by any wash.

They were merely infertile ova, or ova that may have been diseased, but in any case one can always find some amongst almost all Aphis eggs in this condition. These are the ova killed by winter sprays. One need not quote pages of figures in this matter. It is one of those questions of "eyes and no eyes," that every fruit-grower should look to for himself.

Lime-salt wash, or thick hot lime, do not *kill* the ova of the Plum Aphis, but the particles so worry the fragile young that they just lie down and die.

For Apple Aphis eggs where it does not cling to the same extent, it is of very little value.

Aphis eggs are as little harmed by lime-sulphur as by any other previous all-round killer.

With regard to the Red Spider of apple and plum, fuller details will be given. The tables below will explain the utter uselessness of any winter wash for ova. The shoots treated in these tables were not sprayed, they were held under the following fluids for ten minutes each.

Results obtained in 1911 :—

Apple and Plum Red Spider (*Tetranychus pilosus*).

Six shoots each dipped in :—

(1) Caustic soda normal strength. February 10th.
(2) Caustic soda, double strength. February 10th.
(3) Caustic soda, treble strength. February 10th.
(4) Paraffin Jelly. February 10th.
(5) Warm caustic soda, double strength. February 14th.
(6) Warm water (boiling). February 14th.
(7) Lime-salt-sulphur wash. February 14th.
(8) Lime-sulphur wash. February 14th.
(9) Lime-sulphur wash, double strength. February 14th.

These were planted in moist sand and kept in a fairly warm greenhouse, and on March the 17th they were examined.

In all red spiders had hatched, the six-legged young being very restive, except in 5 and 6.

No out-door spraying with lime-sulphur or any other spray fluid can act as well as a ten minute dipping, and the result is given. The only positive results obtained were with boiling water and very hot caustic soda.

Only this year samples of Red Spider laden bark sprayed

with lime-sulphur, have been sent me, and the ova have hatched out quite normally, just as one would expect.

With all insect ova it is the same, and the sooner the fruit-grower gives up the idea that lime-sulphur or any other wash is going to destroy them the better.

The experiment given here with various washes on the ova is only one of some hundreds that have been made. I merely quote back to it because I hear so many people saying that lime-sulphur kills the eggs. They should also watch the normal loss through what we call *pro tem.* infertile ova. The fact that many Aphis eggs and other insect and mite eggs are infertile deceived me in 1904 in experimenting with caustic soda as an ovicide.

Further experiments with lime-sulphur were made in 1913, as follows :—

A. Ova of *Aphis pruni*.

(1) 6 ova on shoot ; (2) 2 ova on shoot ; (3) 7 ova ; (4) 3 ova ; (5) 6 ova ; (6) 4 ova, all immersed for ten minutes in full strength lime-sulphur. Six shoots with 2, 8, 3, 2, 4, 1, ova left on as checks, February 12th. Of the dipped shoots the ova hatched as follows :—(1) 6 ; (2) 2 ; (3) 4 ; (4) 3 ; (5) 4 ; (6) 3. On the untreated shoots the result was (1) 2 ; (2) 5 ; (3) 1 ; (4) 2 ; (5) 3 ; (6) 0.

B. Ova of *Aphis sorbi*.

(1) 120 ova ; (2) 70 ; (3) 90 ; (4) 7 ; (5) 29 ; (6) 105. These were dipped for ten minutes. Two shoots kept as checks :—(1) 170 ; (2) 55 ova.

The result was as follows :—(1) 60 hatched ; (2) 25 ; (3) 70 ; (4) 2 ; (5) 12 ; (6) 68. On the two untreated shoots the result was :—(1) 100 ; (2) 21.

C.—Ova of Apple Sucker (*Psylla mali*).

Six shoots dipped for ten minutes :—(1) with 17 ova ; (2) 14 ; (3) 6 ; (4) 20 ; (5) 12 ; (6) 10. Six untreated shoots as follows :—(1) 12 ova ; (2) 5 ; (3) 12 ; (4) 11 ; (5) 20 ; (6) 2. These were dipped on February 2nd. Six ova hatched on the dipped shoots out of 79, and 3 out of 62 on the untreated. This was repeated on March 2nd, as follows :— (1) 3 ; (2) 14 ; (2) 20 ; (4) 22 ; (5) 4 ; (6) 11 immersed as before. The six untreated shoots had (1) 7 ; (2) 14) ; (3) 12 ; (4) 3 ; (5) 9 ; (6) 11 ova. From the immersed ova, 74 in

number, 62 young emerged, from the checks, 56 in number, 42 emerged.

On one shoot was an ovum of the Winter Moth, on another, five. All these hatched out.

D.—Ova of Red Spider on Plum (*Tetranychus pilosus*).

Ten shoots heavily laden, only one counted, and this had 370 ova on it, the others would average about the same, immersed for ten minutes.

Ten left as checks. February 23rd. On the one shoot with 370 ova practically every egg hatched out, and in two others only about half, in the rest about two-thirds.

In the checks the eggs were not counted, but on two a considerable number did not incubate, and on one nearly half the ova appeared to be dead.

From these results it can be judged that little or no benefit is derived from spraying with lime-sulphur as an ovicide.

On the other hand, I must mention Gillette's results in the States. He concludes as follows: Lime-sulphur mixture made by the 15—15—45 formula was also used against eggs of all the plant lice mentioned, and also on those of *Myzus elæagni*. In this strength the lime-sulphur was a marked deterrent to hatching, but all the species hatched to some extent, and some rather freely. Weaker application had little effect. Where strong lime-sulphur applications are made, many lice die from contact with the lime-sulphur, whilst struggling to extricate themselves from the egg-shell, and others die after leaving the shell and before taking food."

Weldon† obtained similar results with *Bryobia pratensis*, ova. They hatched, but the young died, whilst with Tetranychus it had no effect.

† *Journ. Eco. Ent.*, III., 432, 1910.

III.—The Effect of Lime-sulphur as a Summer Insecticide.

Used at the reduced strength as a summer wash, lime-sulphur has little or no insecticidal value, except on some Scale insects, and a few acari to a slight extent. Trials have been made on the following insects :—(1) Rose Aphis ; (2) Black Fly on Broad Beans ; (3) Mealy Plum Aphis ; (4)

Cuckoo Spit; (5) Rose Sawfly; (6) Winter Moth; (7) Tent Caterpillars; (8) Tortrix Moths; (9) Apple Sucker; (10) Woolly Aphis; (11) Flea Beetles; (12) Cabbage White Butterfly; (13) Mussel Scale; (14) Brown Scale; (15) Big Bud Mite; (16) Pear Leaf Blister Mite; and (17) Red Spider on Ivy.

Rose bushes were sprayed twice at a week's interval in July, and the Aphis were unharmed.

Plums badly attacked by Mealy Plum Aphis were soaked with this wash and no harm was done to the aphides.

Cuckoo Spit was quite immune against it; so also was the Black Fly on Broad Beans. To some extent the Rose Leaf Sawfly appeared to be checked by it, but as the larvæ were nearly mature it is possible they fell to the soil and pupated, a search was not made.

In two cases trees attacked by Winter Moths were sprayed in early May, and it appeared to affect the young larvæ to some extent, on another tree I could detect no harm done to them. Larvæ more than half grown were not affected in the least, nor were Tortrix larvæ. Six other trees were heavily sprayed and not a larva died on them.

The same trees sprayed with it against Woolly Aphis had a certain amount of Apple Sucker. These were sprayed in early May and neither pest was harmed. Turnip and Cabbage were sprayed in May and July, when attacked by Flea Beetles, with no better results. Cabbages in July being eaten by the larvæ of the Large Cabbage White Butterfly were not cleared of these caterpillars by its use.

Mussel Scale and Brown Scale were affected by it to a considerable extent, especially the former, the spray being put on heavily in late June, the larvæ were killed.

The effect on Brown Scale was not as good, compared to its effect in winter, but most of the matured females were killed. Black Currants attacked by Big Bud were sprayed in 1913, first on March 27th with winter strength, on March 20th, April 4th and May 15th, with summer strength. These bushes were more affected in the year 1914 than they had ever been.

A large standard pear and a William, invaded by the Pear Leaf Blister Mite, were sprayed as the leaves opened, and

again when the fruit was set. The disease was not a bit checked. At winter strength, however, a good spraying on February 27th on two trees, and on March 4th, materially lessened the attack and in some previous experiments this wash was found to completely cure the trees put on late in February; in a few cases a subsequent spraying when the leaves were out with paraffin jelly was necessary.

The lime-sulphur-salt wash was, however, far more potent as a winter wash for this pest than plain lime-sulphur. Ivy loaded with the Red Spider (*Bryotiæ pretiosa*) was drenched with lime-sulphur in May, many red spiders were knocked off by the dripping of the fluid, but it had practically no effect in killing the mites. Similar results were obtained in 1912 with the Red Spider of Gooseberry (*Bryobia ribis*).*

Results obtained by feeding caterpillars on sprayed foliage were by no means encouraging, in some cases a few larvæ of Winter Moth, Tortrix and Lackeys died, but the percentage was so small that it was not considered worth while to continue this subject. Scott and Siegler (U.S. Dep. Agri. Bur., Ent. Bull., 116, pt. iv. pp. 81-90, 1913), however, found that lime-sulphur, hitherto considered only as a contact spray, has decided value as a stomach poison, especially in the case of the Codling Moth and Fall Web-worm.

Herr L. Fulmek, writing on Lime-sulphur Mixture (Mitt. der. k. k. Pflanzenschutz-station Wein. 1913. p. 9), summarises thus: "It can only be used against a few specific pests, such as scale insects, gall mites and fungus diseases. It can be used instead of the lime-copper mixture, and is to be preferred on the ground of its cheapness and its harmless effect on the green parts of the plant. As it is not, however, a universal remedy, lime-copper mixture, and other recognized remedies should not be put on one side."

Safro (Journ. Eco. Ent. V., pp. 385-395, 1912) has shown that this wash has no baneful effect on the Codling Moth ova, and ends by saying: "It is evident that lime-sulphur, even too strong for use on foliage or fruit, is at best, an uncertain ovicide." He treated 100 eggs with a 1-30 dilution of clear lime-sulphur, testing 30 degrees B. Of this number

* This is now known to be the same species as the Ivy Red Spider (*Bryobia pretiosa*).

85 hatched, 1 was accidentally killed, and 14 failed to hatch, due to other causes. This 14 per cent. includes, undoubtedly, some "natural" and "accidental" mortality. Deducting these latter items—or even ignoring them—the lime-sulphur mortality amounts to very little indeed.

Its inefficiency against Cabbage Aphis has been shown by Herrick (Journ. Eco. Ent., IV., 224. 1911). A series of plants were dipped in solutions of lime-sulphur 32.5 Beaumé, in proportions of 1 to 40, and 1 to 30; were quite badly burned in every case, and only a small percentage of the Aphides died.

Hinds and Bishopp (Journ. Eco. Ent., I., 91. 1908) found it had no effect on the Peach Aphis (*Myzus persicæ*) used in spring just before the buds burst.

Russell (Journ. Eco. Ent., I., 377. 1908) in using this wash for Red Spider in Florida *Tetranychus bimaculatus*, records that it killed 76 per cent. by one spraying, the wash was made of 1 lb. of lime, 1 lb. of sulphur, to 25 gallons of water.

Its effects upon Mites is so varied, apparently due to climatic causes, that it must not be relied upon any more than as a mite ovicide.

The Direct Effect upon Coccidæ.

Whilst the effect of lime-sulphur wash on Brown Scale (*Lecanium persicæ*), on Oyster Shell Bark Louse (*Aspidiotus ostræeformis*), and San José Scale (*A. perniciosus*), is undoubtedly very good, it must not be assumed that it is a panacea for all Coccids. Its effect as a winter wash for Mussel Scale is very poor. It fails in the Euonymus Scale (Journ. Eco. Ent., IV., 259, 1911). Metcalf states commercial lime-sulphur did not prove to be an effective remedy in any of the strengths used on this scale.

Writing on the Gloomy Scale (*Chrysomphalus tenebricosus*. Comst), Metcalf (idem, pp. 515-54) points out that "None of the commercial lime-sulphur washes were as satisfactory as the soluble oils."

Nevertheless, it has undoubtedly some Scalecide properties, and this is due to the fact that it produces oxidation, and thus the space beneath the scale not only loses its oxygen from

the respiration of the bark,* and the insect, but by the action of the lime-sulphur. Moreover, it undoubtedly softens the wax at the edges of some Coccids, and this dries and sticks the scaly covering more firmly to the tree and prevents the ingress of oxygen.

Indirect Action on Coccids and Mites.

As a wash for Coccids in the egg stage, results clearly point to its inefficiency. Frequently with Mussel Scale (*Lepidosaphes ulmi*) no eggs are destroyed at all, now and again a few. In America, Cooley (Journ. Eco. Ent., III., 64. 1910.) sums up as follows :—" Eggs of the Oyster Shell Scale are unaffected by the application of lime-sulphur solutions made previous to the opening of the buds. On trees so sprayed the young were killed soon after hatching. The intervention of rain-storms before the hatching of the eggs may more or less affect the value of the treatment."

On two occasions I have observed this here, but rain usually washes so much off the trees that in nearly all cases the result is the reverse of good. The same with the Red Spider on Apple and Plum (*Tetranychus pilosus*) where the trees have been sprayed late and the mites have hatched out a few days after spraying and no rain had intervened, and the lime-sulphur powder had been used. Where it had collected rather thickly many of the hexapod young died in a few days, but when the trees had had heavy rain on them the acari matured as usual. This is far more noticeable where trees have been sprayed with lime and salt. The mechanical action of the small particles destroys them. Whether there is any chemical action as well in the case of lime and sulphur I do not know.

Summary.

From what has been shown in the preceding reports of personal experiments and observations, and in the reports collected from abroad, we may sum up that :—

(i.) Lime-sulphur is of no definite value as an ovicide.

* Schafer (Journ. Eco. Ent., IV., 51. 1911) found that apple bark on dormant trees at 11 to 12° C. uses small amounts of oxygen and gives off carbon-dioxide.

(ii.) Its effects upon living insects otherwise than *certain* Coccids is of a very low standard, and in the majority of cases as a contact wash is quite valueless.

(iii.) That it appears to have some slight value as a stomatic poison for some caterpillars, but so many are not affected at all that it can claim no p'ace as a poison wash as against arsenate of lead or nicotine.

(iv.) As a means of cleaning trees as far as insect shelter goes it may as well not be used.

(v.) That it is of definite value as a means of checking Pear Leaf Blister Mite, Brown Scale, and Scurvy Scale, and San José Scale ; and

(vi.) It has under certain conditions a deleterious effect upon the young hatched Mussel Scale, and some of the Red Spiders, but cannot be relied upon to destroy these pests.

ANIMALS INJURIOUS TO HOPS.

Millepedes (*Blanjulus guttulatus* Bosc.) in Hops.

In May Mr. R. Mercer, of Rodmersham, sent specimens of the Small Snake Millepede (*Blanjulus guttulatus*), which he was finding in large quantities in the hop-hills at that time, " especially so where wurzel have been placed by the hill to catch a wire-worm. They attach themselves to the wurzel in such large numbers that each piece is completely covered on the cut side."

On May 7th another similar communication was received from Mr. Edward Goodwin, of Canon Court, Wateringbury, saying, " Some of my young hops are severely infested with Millepedes (*Julus pulchellus*) badly enough in some places to kill the plants."

Some people state that these arthropods only feed on decaying vegetation. This is quite incorrect; they will attack perfectly sound and healthy plant roots, rhizomes and tubers.

Heavy dressings of lime frequently check these Millepedes, which are always most abundant in sour soils and soils generally deficient in lime.

At the same time trapping as mentioned above is worth while following up, as vast numbers are drawn away from the plants and may be killed. Although the *Blanjulus* attack quite sound plant tissues, they are especially attracted to decaying moist vegetable matter and so can easily be drawn away from the hops if they are in a sound condition.

The Bramble Moth (*Acronycta rumicis* Linn.) on Hops.

Several caterpillars of the Bramble Moth, one of the Dagger Moths (*Acronycta rumicis*) were received in July from Kent, feeding on hop foliage.

Some kept under observation in the College hop garden were found to eat the foliage very ravenously, and three or four on one bine soon showed their destructive nature. The leaves were first eaten in holes and then completely destroyed in many cases. The larvæ kept all pupated in the first week in August; those in the breeding jar spun a loose delicate greyish cocoon amongst the foliage.

This is a common moth, a little more than an inch in wing expanse, the front wings deep greyish-brown with grey markings as shown in the photograph, the hind wings are grey, with a darker border; grey thorax and abdomen. It occurs in May, June and July, and is found flying at dusk in woods and gardens. In the laboratory they commenced to hatch out on April 10th, 1914. It lays its eggs on very many low plants, but I am not aware of the hop having been recorded as a food plant. The caterpillars are blackish-brown, each segment black in front with a clear white spot on the sides and an orange one in the middle of each, and a white line on each side spotted with red.

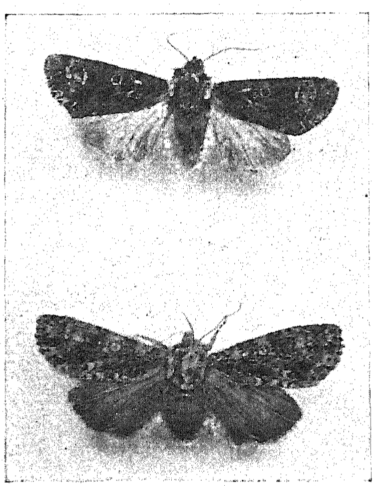


Fig. 25.
THE BRAMBLE MOTH (*Acronycta rumicis*).

The matured larvæ reached a little over an inch in length.

The pupal stage passed in a cocoon as described is usually found in crevices of bark, on palings or amongst moss and *débris* on the ground, but those kept spun their cocoons amongst the hop leaves and on the sides of the jar.

Hops attacked by *Bibio hortulanus* larvæ.

On April 3rd, the larvæ of *Bibio hortulanus* Linn., one of the so-called Fever Flies, were sent by the Farnham, Alton and District Farmers' and Hop-Growers' Co-operative Association, which were being found in numbers in the hop-hills in that district. These larvæ, resembling small Leather Jackets, in general appearance, are often found in masses in hop hills, and there is no doubt that they feed upon the root system and do a good deal of damage.

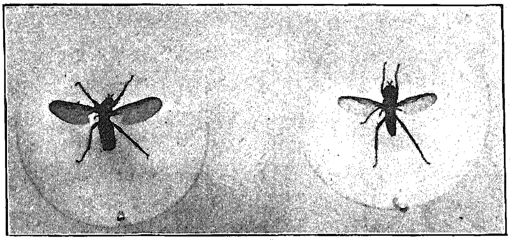


Fig. 26.
Bibio hortulanus. Female and male.

Another species *Dilophus febrilis*, also works in a similar way, and its adults have been recorded by Miss Ormerod as swarming on hops at Rainham, and were sent me in 1912 from Hereford where they were doing the same.

Great numbers were also sent me from Worcester one year, causing similar annoyance. The adults, however, do no damage directly, but indirectly some of these Bibionidæ have done harm by getting caught up and dying in the cones and thus spoiling the sample, but such is very unusual.

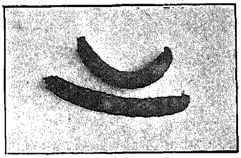


Fig. 27.
Bibio larvæ

The larvæ are usually not noticed in the soil until they are nearly mature, and have done all the damage. Soot and lime are very distasteful to them, and Vaporite I find soon kills them, and many others of the soil fumigants now on the market.

Earwigs (*Forficula auricularia* Linn.) in Hops.

A bad attack of Earwigs (*Forficula auricularia*) in hops was reported from Maidstone in August. The hop poles had the cracks filled with them, and at night the earwigs came out and bit the leaves very badly.

Arsenate of lead was tried as a remedy, but seemed to have no effect upon the insects.

Another attack of Earwigs on hops was also mentioned by Mr. Edward Leney, who said, writing on July 7th, that he had " a piece of hops being badly eaten off by them. Pole work with slope-strings."

The Common Earwig now and again is quite harmful to hops, not only where they are poled, but where wire and string are used. If they are poled, however, the insects neatly hide away in the crevices of the poles and are thus difficult to deal with. Mr. Leney was unable to find any in the ground during the day time. But if they attack in gardens where wire and string are used, they pass the day mainly in the soil and may be got rid of by heavy dressings of soot or in very bad attacks by smearing molasses round the base of the bine, for although they have wings the Large Earwig but seldom makes use of them, and so they are prevented from getting to the leaves.

ANIMALS INJURIOUS TO CEREAL CROPS.

Tulip Root in Oats.

Comparatively few enquiries were received during the year concerning Tulip Root in Oats, due to the Eelworm (*Tylenchus devastatrix*). In some parts of Sussex it was bad, notably in East Sussex, where I saw many fields showing signs of it in May, 1913, between Robertsbridge, Battle and Hastings, and on to Rye, Brede, and into the Weald of Kent.

From Icklesham Mr. Wadman wrote, sending also specimens which showed a combined attack of Tulip Root and Frit Fly, and stated that his oats were again badly attacked, the far worst affected being on an excellent piece of land after a heavy piece of Swedes, folded off by "Falling" sheep. "I bought the best seed grown on chalk, and they came up well and looked well until lately (May 2nd). The trouble is really a very serious one. This is the third year my oat crop has been ruined, and I, in common with many others, will be very grateful if anything can be done. Winter Oats are apparently immune. I have grown some this year for that reason."

Another bad attack was reported from Newenden, S.O. Kent, where the oats in 1912 were a failure through Tulip Root disease.

The only methods of circumventing this attack is to grow winter oats, if this cannot be done then the disease must persist, and can only be ameliorated by top dressings of Sulphate of Potash.

Slugs attacking Wheat.

From Bunney, Nottingham, Mr. Smeeton wrote on February 13th, that he had a field of wheat after seeds that was being greatly damaged by some kind of grub which he enclosed.

The pest was the ordinary Grey Field Slug, *Agriolimax agrestis* Linnæus.

This general feeder at times does a good deal of damage to field crops where conditions have enabled it to increase for some years in the soil.

The only treatment is a heavy dressing of soot, which keeps them off for a time, makes the soil obnoxious to them, and hastens on the growth of the plant. When land becomes badly infested with slug it should have a heavy dressing of basic slag, which is distasteful to these Molluscs, and this has also been found useful as a top dressing.

The Frit Fly (*Oscinis frit* Curtis).

Very few cases of damage by Frit Fly (*Oscinis frit* Curtis) were reported in 1913. Some badly attacked specimens were received on July 2nd from Sellindge, near Hythe, from Mr. Henry Hentom.

The oats were very stunted, the whole crop being similarly affected. The reddish-brown puparia occurred in numbers in the plants.

From Icklesham, Sussex, Mr. Wadman wrote that his oats had been badly attacked by the larvæ of this fly for the past two years, and that in that district he was told that winter oats sown in the spring were immune.

The earlier the oats are in the less liable are they to the attack of the maggot of the Frit Fly.

ANIMALS INJURIOUS TO ROOT CROPS.

The Mangold Black Fly (*Aphis rumicis* Linnæus).

A slight attack of this Aphis took place again in parts of Thanet, but not nearly to the same extent as last year.

Great numbers of the sexuparæ were found in the autumn of 1913, however, on the Euonymus or Spindle Tree (*Euonymus europæum*), and it occurred in vast numbers on evergreen Enonymus in London (*vide* p. 303).

Further trials with paraffin emulsion and other spray fluids were tried on beets and mangolds, and it was found that the amount of good done in the field did not recompense for the expense. Basic slag was then tried as a remedy, and the result is appended here.

Communications received from the Director of Agriculture for Essex, show that this Aphis has been a serious pest in that county for some three or four years on mangolds, and the experiments carried out there show that although many can be killed by spraying with paraffin emulsion, that the cost is prohibitive and only a proportion of the insects are killed.

The failure of basic slag reported here is inexplicable if the same basic slag is used in Germany and Italy. Further trials will consequently be made in 1914.

Basic Slag as an Aphicide.

The use of basic slag as a fine powder against the Beet Aphis (*Aphis rumicis*) has been reported by several German growers of sugar beet, men of repute, as doing great good. It was broadcast over the fields at the rate of 300 to 400 kgs. =661-882 lbs.) per hectare, that is, 2.47 acres. It is said that eight days after this treatment the Aphis disappeared.

In a report by Professor D. Cavazza, of Bologna,* he states that he had made use of this remedy with good effects upon beans, and had also obtained encouraging results against the *Oidium* of the vine. Owing to the great amount of damage done in some years by the Black Fly on mangolds, beetroots, sugar beet, beans, etc., and the unsatisfactory results gained by spraying, except in garden cultivation, it was decided to test this remedy, not only upon the Black Fly of the mangold, bean, etc., the *Aphis rumicis*, but also upon other Aphides as mentioned in the following pages.

The results given here are so totally at variance with those mentioned in the opening paragraph that I propose to carry out the same trials again this year, although under the circumstances one cannot possibly hope for different results. The question to settle was whether the basic slag acted as a direct killer, as a powder insecticide put on the Aphides, or in a secondary way by making the sap unpleasant to them.

If it were merely to act as a contact insecticide, it was of course at once seen that very few of the Aphides beneath the mangold leaves and in the curled leaves, would be touched, and as results on the Continent had shown its beneficent use on sugar beet, it was assumed that it acted chiefly in a secondary manner.

In June an invasion of *Aphis rumicis* took place on broad beans, the alatæ were allowed to breed and large colonies were formed smothering the tops, their excrement falling down and ruining the crop. Four rows right through, badly attacked in the middle of the plot, were heavily dusted (450 lbs. to the acre) with basic slag on July 12th. On August 4th the beans had still any amount of Aphis on them, many had become alatæ and flown as they had also done on the untreated parts, owing to the plants failing through the attack. The treated plot was watched from day to day, and although the basic slag was still holding on to the plants there was no mortality seen amongst the plant lice at any time.

In June currants and gooseberries and some roses were heavily dusted with this substance, some having been previously sprayed with plain soft water. *Rhopalosiphum ribis*, *Aphis*

* Rivista di Agricoltura Parma, XIX., No. 20, pp. 303-310. 1913. "Le Scorie Thomas nella lotta contro i Pidocchi delle Barbabietole."

grossulariæ and *Macrosiphum rosae* were present in great numbers. The bushes were watched from day to day and no mortality was seen amongst the plant lice. As these tests were more thorough than would ever take place in practice, it was evident that basic slag as a "contact killer" was of no value whatever for Aphis attack. It was hoped therefore that some similar results would be obtained as on the Continent from the absorption of the manure by the plant.

Six rows of beetroots, and a plot of mangolds infested with Black Fly were dressed in two ways, half with the basic slag simply broadcast over the plants, at the rate of 400 lbs. per acre; the same amount was blown over the plants in a way that I do not see could be carried out in practice in field cultivation. The ground and plants were then well watered. At intervals of two days the plants were examined, and no mortality amongst the Aphides was noticeable. On some untreated rows double the amount was then used and well watered in, the result at the end of two weeks was just the same. At the normal time the *Aphis rumicis* all became winged and left the plants.

At the same time several pot fruit trees infested with Woolly Aphis were given heavy dressings of basic slag, the amount was not measured, a couple of handfuls being given to each apple tree. Four were left alone, two had the slag watered in. The Woolly Aphis persisted in all of them, and normally migrated to the roots in autumn.

The results thus gained in one year seem very clear, that is that basic slag is of no value whatever as an Aphicide, and yet we have totally different results obtained in Germany and Italy.

That the basic slag is the same I *assume* merely from the fact that this matter was pointed out to me by agents for that manure before I saw the results obtained by those on the Continent.

Where such very marked contradictions occur it is certain that some errors have been made, and consequently similar experiments on the same lines but under different conditions, will be carried out in 1914. A simple remedy for Black Fly on mangolds is very essential, as spraying with soap and quassia or paraffin jelly, although vast numbers may be killed

in a garden when sprayed by hand, is not of any real value in field cultivation.

Mr. A. Malim Smith, of the East Anglian Institute of Agriculture, Chelmsford, wrote me on August 5th, that they had also been experimenting with Black Fly on mangolds and beans, using a horse machine, but with very poor results, the wash used was a paraffin emulsion, knapsack spraying he found for field work was too costly and tedious.

The German reports are as follows :—" In the experiments to test different means of combating the Aphis, the distribution of basic slag has proved the best here (Province Posen). I therefore recommend an application where the beet is badly attacked by the Aphis of 250 lbs. of basic slag per acre, if possible in two doses. This measure at least protects the young leaves ; and also drives away the greater number of the Aphis from the leaves already attacked." H. Bruning (Deutsche Zuckenindustrie.)

Another report from Posen says : " My sugar beet crop of 100 acres was in danger of becoming a complete failure, as the beet was completely covered with Aphis. After having seen I could not get rid of the Aphis with heavy dressings of nitrate of soda, I tried 600 lbs. of basic slag, on two acres, and noticed after three days that the Aphis fell off the leaves, and the beet regained a light and healthy colour. I at once applied it at 300 lbs. per acre. Although a portion of the slag was applied in the morning when the dew was on the leaves, and another portion in the day, during bright sunshine, the effects were the same."

ANIMALS INJURIOUS TO GRASS LANDS AND FODDER CROPS.

Leather Jackets in Grass Lands.

Complaints of the damage caused by Leather Jackets, the larvæ of various Daddy Long Legs (*Tipulidæ*) (Fig. 28) are becoming more frequent in Kent. This is due to some untold factor which has caused an unprecedented increase in the number of Crane Flies or Daddy Long Legs during the last three years.

Let us first note that this increase is not as at first thought littoral. From Bayham Home Farm, Lamberhurst, Kent, samples of turf and soil were sent on May 15th, 1913, that was absolutely laden with Tipulid larvæ, by Mr. H. E. Rudd, who wrote that the land was terribly affected with the grubs, which were killing the grass.

Other bad attacks occurred at Hawkhurst, Swanley, Leicester, etc., of a similar nature.

There is no doubt, however, that an extraordinary increase in both *Tipula oleracea* and *Tipula paludosa* took place in 1913, around the East Kent coast. At and near Whitstable I found the sea covered with dead Daddy Long Legs, blown

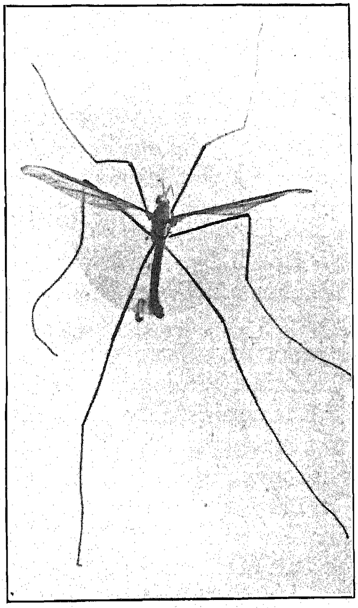


Fig. 28.
Tipula oleracea.

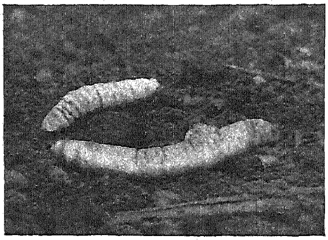


Fig. 29.
LEATHER JACKETS.

out by the wind, in places thickly heaped up and vast numbers of dead ones were washed up by the tide. The probability is that 1914 will see a bad attack of Leather Jackets in that region. Starlings and plovers should be encouraged all we can, as nothing can be done to grassland attacked by them, except giving it dressings of basic slag and heavy rollings.

The Clover Midge (*Amblyspatha ormerodi* Kieffer).

Clover plants badly damaged were sent in December, 1912, by Dr. Oldershaw, of the East Suffolk County Education Committee. The plants were badly infested with the larvæ of the Clover Midge (*Amblyspatha ormerodi* Kieffer), and had also some Weevil larvæ on their roots, which proved to be those of *Sitones puncticollis* Stephens, and they also had a slight affection of Eelworm (*Tylenchus devastatrix*), one of the causes of clover sickness. The Eelworm were in such small quantities in some of the diseased roots that there is little doubt but that the Cecidomyia larvæ were the real cause of the damage.

This Midge which has been referred to by Dr. Stewart MacDougall (Journal Board of Agriculture, Vol. XX., No. 3, pp. 225-230, 4 figs. 1913) has been recorded by him as injurious in Norfolk, Suffolk, Essex, Lincoln, Huntingdon, Cambridge, Surrey, Hereford and Shropshire.

It appears only to attack red clover. The larvæ are various shades of red, and can at once be told by the marked anchor process (Fig. 30A).

They are found in the plants just at ground level, and here the apical tissue is decayed, but no Tylenchus occurred, and also in the young side shoots, many of which had rotted away. MacDougall refers to other damage that I was unable to find in the samples sent me, such as "in the unopened leaflets marked by black patches" and in "unexpanded

buds." Some were also present in the soil surrounding the plants sent. The larvæ had not pupated by February and unfortunately the jar was left to dry up, and they did not hatch out.

MacDougall says the ova are probably laid on the unopened bud or on the young leaves.

The appearance produced by this pest in the field is very similar to that produced by *Tylenchus devastatrix* and *Sclerotia*.

Some doubt has been placed upon the actual damage done by this Cecid, but in the case sent me, and one observed near Wye, they were undoubtedly the cause of the clover dying off, as no other parasite was present in many plants. The reader is referred to MacDougall's article for further information.

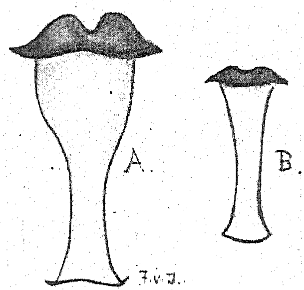


Fig. 30,
ANCHOR PROCESS OF
A. ormerodi AND *D. trifolii*.

Another Cecid larva is frequent in white and red clover, namely *Cecidomyia trifolii*, F.Lw., which occurs in the swollen leaves, which later die and turn brown. The eggs are laid on the leaves before they have opened, the larvæ living under their cover. It can at once be told by the different anchor process (Fig. 30B).

A third species, *C. leguminicola*, lays its ova in the flower heads of white, red and Alsike clover, and ruins the seed crop.

ANIMALS INJURIOUS TO VEGETABLES.

The Cabbage Stem Flea Beetle (*Psylliodes chrysocephala* Linn.).

Specimens of young cabbage and kale were received in March from Mr. Chittenden, of the Royal Horticultural Gardens at Wisley; also from Cornwall and Blackheath, which had the stems destroyed by the tunnelling of a small maggot. Similar damage was noticed to cabbage and turnip on Romney Marsh in 1912 and 1913. Those sent by Mr. Chittenden came from Hayling Island, where they were tunnelling into the stems just below the growing point, or half-way up the stem. (Plate VIII.).

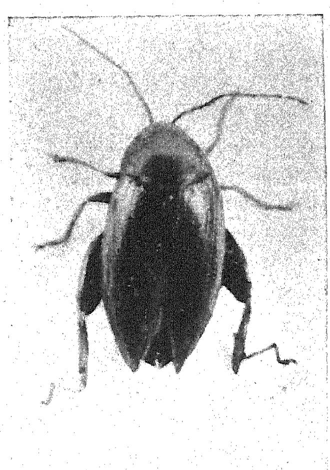


Fig. 31.
THE CABBAGE STEM FLEA BEETLE (greatly magnified.)

The larvæ proved to be those of the Flea beetle—*Psylliodes chrysocephala* of Linnæus.

The damage caused by these larvæ is very characteristic (Plate VIII.), the stem from ground level or from a little below ground level, is hollowed out up to a height of five or six inches, whilst now and again it goes up even into the leaf stalks. In some young plants sent me the stalks were quite hollowed out and were black inside, a small hole to the exterior was noticed in most specimens close to the ground or just below it. This hole frequently splits,

and the plant, bends or breaks off at this level. When it attacks turnips according to Miss Ormerod, the larvæ will bore into the bulbs as well as into the stalks. I have only found them in the stalks where the crop was grown for seed on Romney Marsh.

The only two records of the larvæ of this beetle doing any harm in Britain are given by Miss Ormerod (the Entomologist XI., pp. 217-220. 1878), and by Professor Carpenter ("Injurious Insects and other Animals observed in Ireland during the year 1906," Eco. Pro. R. Dublin Joc., pp. 427-430, pts. xxxix. and xl. 1907).

On the Continent it is a well-known pest to the rape crop (*vide* Ritsema Bos, in Tierische schädliche und nützliche 367. 1891; Sofie Rostrup, Nogle Iagttagelser augaaende Skadedyr I. 1907 og 1908., p. 294, figs. 5 and 6, 1909), and Kaltenbach, in Die Pflanzenfeinde aus der Klasse der Insekten, 29. 1874; and Report of the Bio-Entomological Station of the Zemstvo of Bessarabia; Experiments in fighting the pests in Winter Rape, pp. 5 (1913).

The adult beetle (Fig. 31) is from 4 to 4.5 mm. long, of a bright metallic green colour, with the front of the head and bases of the antennæ yellowish, the legs have the femora of the fore and mid pairs and the tibiæ of the hind pair yellowish.

The beetles hatch in June or even early May. The larvæ previous to pupating leave the plant and enter the soil, where they form earthen chambers in which they pupate. Those under observation formed the earthen cell on March 9th, pupæ were found on the 23rd of April, and the imago hatched May 8th.

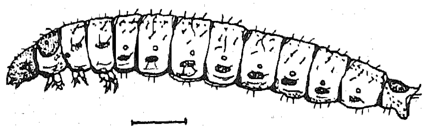


Fig. 32.
LARVA OF *Psylliodes chrysocephala* Linn.

Carpenter found the pupal period to be three weeks. Some sent to me took four weeks to hatch. It appears, as I have found larvæ of this species in turnip stalks and cabbage in July, and that they are found again from February

to May, that there are two broods, which, however, must vary somewhat to what we find on the Continent.

The specimens hatched in June or late May evidently oviposit and their progeny mature before autumn, and hibernate, then come out in spring and lay their eggs, giving rise to the brood of larvæ we find in the cabbage plants from March to late May or early June. The larva was first described by Carpenter. When fully grown it is 8 mm. long, white to creamy-white in colour, the head, pronotal shield and ninth abdominal tergum brown; there are the normal three pairs of short true legs and the characteristic anal proleg seen in the Flea Beetles. The abdomen has transverse rows of hairs (Fig. 32).

The pupa is creamy white.

No damage due to the adults has been noticed in Britain, but on the Continent it is frequently harmful by devouring the leaves and flower buds of rape, according to Ritsema Bos, and as recently reported the leaves, in the Preliminary Report issued by the Bio-Entomological Station of the Zenistvo of the Government of Bessarabia at Kischiner.

Miss Ormerod's record was from Middlesex; Carpenter's from Limerick. It appears to be only an occasional nuisance in this country.

This Cabbage Stem Borer must not be confused with another common on Romney Marsh, larger in size and of typical Weevil form, which appears to be *Baris laticollis* Marsh, or an allied species. As I have never been able to hatch this species its exact identity remains to be proved.

Phædon cochleariæ attacking Red Cabbage.

In July an enquiry concerning damage to red cabbages was received from Frittenden. Mr. James Ashbee wrote as follows:—"I am sending you a few insects. On Tuesday last a great number were seen on a weed in the garden. My man pulled up the weeds and threw them on one side and planted red cabbages. This morning the cabbages are practically destroyed."

The live beetles were at once placed on red cabbages in my garden, under a muslin tent, and soon set to work eating them, in ten days they had completely destroyed six plants.

These beetles, known as *Phædon cochleariæ* of Fabricius, are very common and found all over Britain. They are oval and convex, of a deep bright steel blue colour, with the anal segment of the abdomen dull reddish at the sides; the antennæ black, and are from 2½ to 3½ m.m. long. They and their larvæ feed on various Cruciferæ, and often do much harm to rape and mustard, as well as to cabbage. They are particularly common in marshy places.

This and the allied *P. armoraciæ* Linnæus, are well-known mustard pests in the Fens.

Brassicæ damaged by *Phytomyza flavicornis* Meigen.

In 1910 I made reference to this attack (Report on Economic Zoology for the year ending September 30th, 1910, p. 100). Again in September, 1913, the damage caused by the larvæ of this fly was very serious in the Blackheath district. Mr. North, who sent a large mass of plants and leaves attacked by this insect, wrote as follows:—" It is still a great pest here. My seed beds of brassicæ were much infested, the worst being cauliflowers, the most resistant kale. When pulling for planting out I noticed in the epidermis, generally in the region of the hypocotyl, that the fly had laid eggs or inserted them at right angles to the stems, and in one

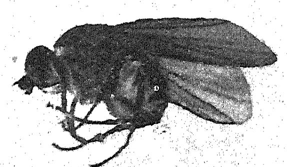


Fig. 33.
Phytomyza flavicornis (× 10.)

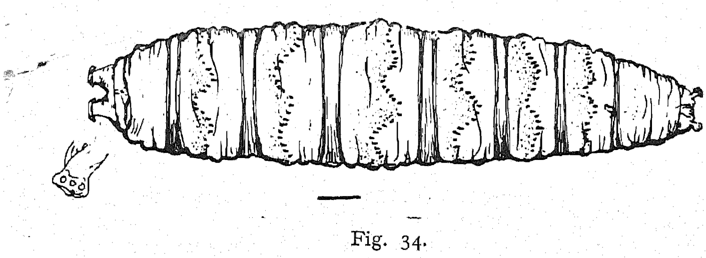


Fig. 34.
LARVA OF *Phytomyza flavicornis.*

or two instances I saw the projecting egg just after insertion. The stems were ruined to such an extent that I rejected for planting all that were so affected, for I do not think they would have lived, but some seemed only to have been affected superficially, as if they were ruined only in the outer skin. Now, nearly all, I might say all, the brassicæ in the garden are affected. The turning yellow of the lower leaves of the brussels sprouts, kales, cauliflowers, broccoli, savoys, coleworts and spring cabbage, would at first sight be regarded as natural. It may be, but the yellowness is hastened by the presence of the maggots in the tunnels in them. In some cases I have found the pupæ in the tunnels. It must seriously affect the value of the crop as premature

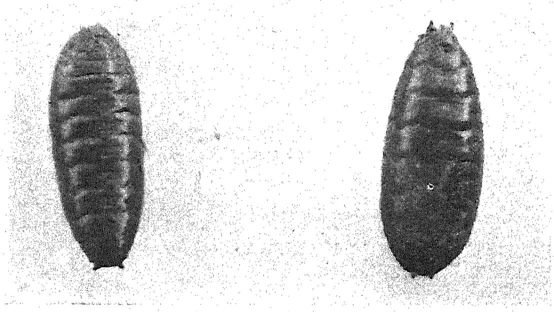


Fig. 35.
PUPARIA OF *Phytomyza flavicornis* (× 12).

ripening of the leaves means loss. The premature bursting of the hard heads of spring cabbage I attribute to this pest. The outer leaves turning yellow and falling, restricting the flow of sap and deviating it to the heads, causing turgidity and thus bursting."

The plants sent showed that the leaf stalks and petioles were completely tunnelled by many of the larvæ, some of them were quite black and decayed within; others only showed a few tunnels (*vide* Plate IX).

When mature the larvæ escape by eating their way out of the petioles and mid rib, leaving behind marked scars as seen in the photograph (Plate X).

The larvæ (Fig. 34) fell to the soil and pupated in brown puparia (Fig. 35) irregularly. Larvæ of all sizes were found in the same plant.

Those that pupated on November the 12th, hatched on December 1st; others which pupated on November 22nd to 24th, hatched out between December the 17th and 31st. As soon as they hatched the flies crawled up the sides of the jars, and in a few hours became active, and by next day some were found in copulâ. Four days later they were ovipositing again on the cabbages, the ova being laid in all manner of places, the ova being placed just in the skin of the stem or leaf stalks.

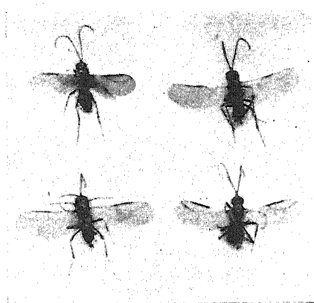


Fig. 36.

PARASITES OF *Phytomyza flavicornis*.

They are much subject to the attack of several *Hymenopterous* parasites, one of which is shown here (Fig. 36).

The Cotton and Melon Aphis (*Aphis gossypii* Glover).

In July Mr. A. G. L. Rogers, of the Board of Agriculture and Fisheries, sent me some Aphides which were attacking cucumbers at Sale, Manchester. On mounting these I found to my surprise that they were the so-called Cotton Aphis (*Aphis gossypii* of Glover), which is also known as a serious pest of melons, cucumbers and all Cucurbitaceæ.

An examination was made at once of some slides I have of Aphis attacking marrows and cucumbers, taken at Wye and other places, and which I had named *Aphis cucurbiti* Buckton, and I find that they are no other than the Cotton Aphis (*Aphis gossypii* of Glover). There is no doubt that Buckton's species is only this insect which is subject to great variation, and which is now known to attack a very great number of plants in America, Africa and Asia, and which is well-known in Russia and probably occurs all over the globe, like many other species of Aphis.

From an examination of material from America, Africa, India and Russia, I feel we are safe in sinking Buckton's *Aphis cucurbiti*,* Walker's *Aphis illata*†, and Koch's *Aphis malvæ*,‡ as synonyms of this world-wide species.

Bibio Larvæ attacking Vegetables.

Numerous larvæ of *Bibio* sp. ? were sent in February from Farnham, found in potting soil, with a query as to whether they would harm lettuce, etc., if the soil were used in frames.

Most of the Bibionid larvæ are injurious to roots, especially so to the roots of delicate plants like lettuce and seedling cabbage and young flower plants.

They frequently occur in masses in the soil when it is dug over. This is due not to any gregarious habit, but I fancy from what I have seen, to the larvæ collecting around any decaying or sound vegetal matter left in the soil. Fc instance, in digging over some ground where cabbage ha been grown, during the spring of 1913, great numbers wer found around one or two old cabbage roots left in the grounc one mass containing some hundreds of larvæ, and I found i was easy to clear soil of them in a garden by placing masse of roots in the soil here and there and then digging them u in early March and destroying the larvæ.

There seem to be several species that occur in numbers i soil, including *Bibio hortulanus* and *Diplophus febrilis*, whic may occur in greatest numbers. They attack, like the wire worm, all manner of roots, but their effect is most noticeable on delicate plants like lettuce and seedlings.

The Cabbage Maggot (*Phorbia brassicæ* Bouche).

Damage caused by the Cabbage Maggot, the larva of the fly *Phorbia brassicæ* of Bouche (Fig. 37) was reported from Wareham, Dorset, on June 12th; also from Fowey in Cornwall, in June, and from Colchester, Essex. With the attack recorded here of *Phytomyza* on cabbages, etc., from Blackheath, were also sent some larvæ of *Phorbia brassicæ*. It was pointed out to correspondents the importance of discarding any plants,

* Mono. Brit. Aph., II., 56, pl. liv., Figs. 1 and 2. 1887.

† Zoologist, VII., App. xliv. 1849.

‡ Die Pflanzenlause. p. 125. 1874.

1 setting them out, that show the least sign of disease, as pest is too frequently carried out with the young plants, . also the importance of *digging* up any that show signs of ;gging at once, and burning them, and filling in the holes .h Vaporite, or watering with Creol, which is fatal to the væ that may be left in the soil.

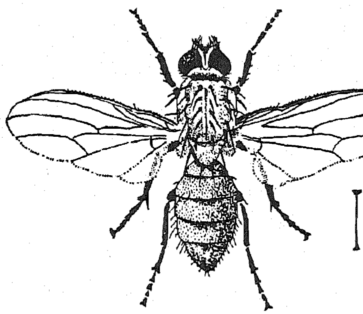


Fig. 37.
THE CABBAGE ROOT FLY
(*Phorbia brassicæ.*)

Soot is undoubtedly a deterrent to the fly, and where it is prevalent in a district it is certainly worth while to dibble the plants with a handful of soot and lime and ash mixed in equal proportions, and then later give a dressing of soot broadcast over them. The method of card discing previously mentioned is academically quite right, but practically it is not possible, unless one has a few plants to deal with. In large breadths of cabbages, etc., it is quite out of the question.

ANIMALS INJURIOUS TO ORNAMENTA PLANTS.

The Chrysanthemum Eelworm (*Aphelenchus Ritsemabo* Schwarz).

In the *Fruit-Grower, Fruiterer and Florist,* in 1908 Mr. Emptage referred to the damage being done to chrysanthemums by Eelworm, and referred the species to the Fern Eelworm (*Aphelenchus oleisistus*). Since then this attack has gradually spread, until now we find it in pretty nearly all districts.

Recently Mr. Emptage has found out the life-cycle of this Eelworm, and Dr. Ritsema Bos writes that it is not *olesistus* as he imagined, but a new species described by Dr. Schwarz as *Aphelenchus Ritsemabosi.*

The disease manifests itself in a very marked manner. The lower leaves first turn brown and shrivel up, and by degrees this spreads right up the plants, and later the blossom buds shrivel up or become stunted and deformed, and the whole plant goes. In others only some leaves are affected, and then ill-formed and stunted blossoms may occur, but never of any commercial value.

The Eelworm is found in numbers in the attacked leaves in an immature condition, but nearly full grown. Not only do we find them in the leaves, but in specimens sent me I found them in the stems. Judging from what I have seen I should say they pass from leaf to leaf, *via* the stem. The reason I say this is because I have found them in the stem.

Mr. Emptage thinks that the Eelworm is in the soil or manure, and that during times of rain or heavy dews it makes its way up on the outside of the stems of the plants, entering

the lower leaves first by way of the stomata. He says "There can be little doubt, that as the Eelworm finishes up one leaf, when the conditions are moist enough, it passes from leaf to leaf until it reaches and destroys all the leaves on the plant."*

It is quite likely that this happens, although under such conditions I have failed to find a single Eelworm on the leaves.

The interesting point, however, is that we may find

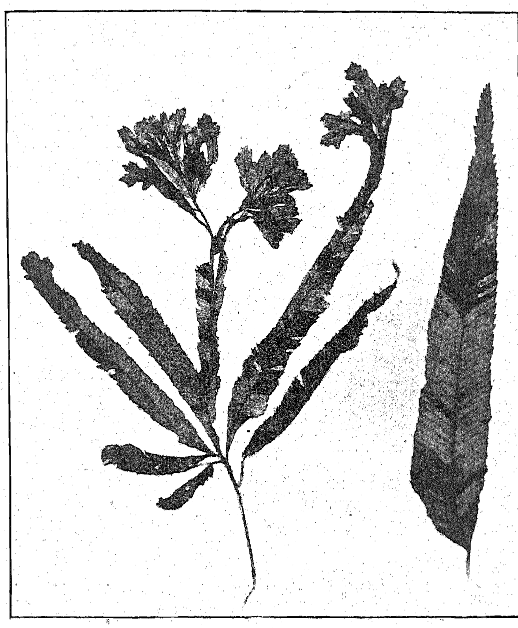


Fig. 38.
FERN LEAVES ATTACKED BY *Aphelenchus oleisistus.*

countless worms in the foliage, and yet no sexual forms are found, no larvæ, no ova.

In 1913, Mr. Emptage found the breeding site, namely in the flower buds. He writes: "When we came to examine the large bud, the size of a farthing (it was a disbudded plant)

* *Fruit-grower, Fruiterer and Florist,* Oct. 23rd, 1913, p. 494.

we found the centre of the bud diseased. Microscopic examination of a small portion of the *dêbris* contained in the centre of the blossom showed us that we had at least found one of the breeding places of the pest. Upon the slide were large numbers of Aphelenchus in all sizes, together with very large numbers of ova." Specimens sent me by Mr. Emptage showed the sexuales in numbers in the buds, many ova and countless larval stages, and later I found the same in some badly malformed blossoms in my garden. These blossoms rotted and became a seething mass of larvæ in time.

Professor Dr. Ritsema Bos wrote saying " I found in the buds sent adult eelworms, larvæ in the most different stages, and ova. Indeed, I am totally convinced that the chrysanthemem Eelworm breeds in the buds," and in a later letter to Mr. Emptage he says : " I had identified this eelworm with *Aphelenchus olesistus*, but Mr. Schwarz, of Dahlem (' Bioglogische Anstalt ') distinguishes it now as a new species, which he calls *Aphelenchus Ritsemabosi.*" Thus a very interesting and very important disease in chrysanthemums has been unravelled by Mr. Emptage, and I must express my thanks to him for so kindly sending me material showing the sexual stages in the buds.

Some of the decayed material sent was kept moist in soil, and I found that the ova hatched in the soil, but the larvæ died. On the other hand the larvæ already hatched in the blossoms lived in the soil. In two pots I put cuttings of chrysanthemums that were perfectly healthy and in March I found that the larval eelworms had grown and had penetrated into the roots.

It thus seems that this Aphelenchus can be distributed in soil and that any dead chrysanthemums thrown into a rubbish heap may serve as a serious source of infection.

There is a still more potent factor in its distribution, namely by cuttings. I found this worm in one plant of my own that was healthy, but had not grown away quite right, no one would suspect Eelworm—anyone would use it for cuttings. It is quite likely that it is spread in this way to a very large extent. Consequently we must be very careful of two things. First that cuttings are only taken from strong, healthy stock, so as to guard against that possible mode of

carrying infection, and secondly that all soil used is sterilized by heat or steam. There is no known remedy for such an attack.

Eelworm in Larkspurs.

Some very badly stunted and deformed Larkspurs were received on the 17th of August, from Wotton-under-Edge, Gloucestershire, photographs of two of which are reproduced here (Plates XI. and XII). A bed of over two hundred plants had over half of them, as shown in the photographs. The bed had been deeply dug over and well manured. The year before there was no sign of the disease and only artificial manure was used. In the autumn previous to this attack the bed was planted with double white arabis, narcissi and tulips. No other plants grown there, such as geraniums, salvias and nemesias were attacked. Some of the plants sent me were no more than a foot high, others were dying off, and all showed the curious ragged appearance seen in the photographs.

An examination showed that the stems were full of Eel worms up to about six inches. They were *Tylenchus devastatrix*, mostly mature females, many full of ova, yet I could find no ova in the plant tissue. Search was made in the leaves and the blossom, but no Eelworm were found. In one specimen, the stem about two inches above the root was literally swarming with the worms, which seemed to be almost entirely present in the outer portions and were easily found by merely scraping the stem with a moist scapel and putting the *débris* on a slide.

These worms were kept and placed in some soil in which young Larkspur plants were placed. In January, 1914, these were examined, and the Eelworms were at once found in the plant tissue, although the plants then showed no ill effects from their presence. By March 20th, however, some of the young plants looked unkindly, and the foliage a bit twisted.

The curious growths shown in the photographs reproduced here were mainly alike, but in some no signs of blossom spikes had appeared, in a few, small stunted blossom heads developed as shown in Plate XII.

There is no doubt that this very marked disease is due to *Tylenchus*, and that it attacks the plants when in the young stage, but does not show until some time after.

When such occurs in beds, as in the case reported here, the plants should be pulled and burnt, and the soil well watered with 0·1 per cent. solution of Creol and left for some two weeks, then dug over and watered again.

The probability is that in this particular case the Eelworm was introduced in the manure.

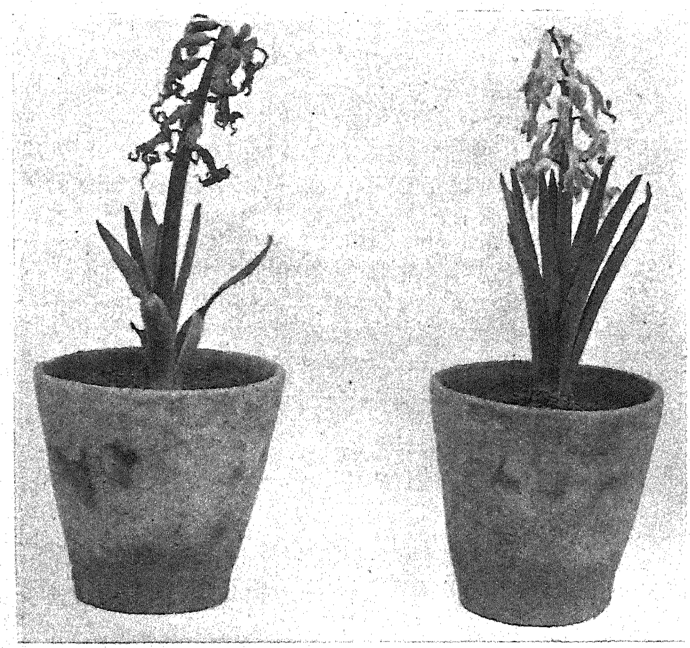


Fig. 39.
HYACINTHS DAMAGED BY EELWORMS.

An Attack of Eelworm in Hyacinths.

An interesting attack of Eelworm in Hyacinths occurred at the College, which practically destroyed all the plants. The cuiious stunted appearance produced by this Nematode is clearly shown in Fig. 39.

None of the plants reached more than four or five inches high, and then the small stunted blossom spikes died off. The leaves showed pale spots of an elliptical form, and the edges of these turned brown and then the tips of the leaves turned pale brown and died. An examination showed very few Eelworms in the bulbs, but by teasing the leaves in water they were found to contain *Tylenchus devastatrix* in considerable numbers, not only in the dead tissue, but also in the surrounding green tissue; none could be found in the small shrivelled and shrivelling blossoms, but in one case many were in the rachis. The bulbs seemed fairly healthy, but one showed a brown diseased streak in it, and here the same *Tylenchus* was found to be swarming. No ova whatever were to be found, and I could not detect any in the females I examined, but on transferring some of the crushed leaves to a test-tube filled with distilled water, I found ova and young Eelworms two weeks after.

The presence of *Tylenchus* in hyacinth and tulip bulbs is very frequent, and there is no doubt that infection comes from the bulbs, and as the bulbs so affected cannot be told from healthy bulbs unless cut up, it is impossible to guard against this disease.

One thing is certain, and that is that any plants showing this disease should be at once destroyed, and the soil either burnt or treated with Creol.

This attack in hyacinths is well-known—the Eelworm originally having been described as a distinct species—*Tylenchus hyacinthus*.

White Worms attacking Begonias.

Specimens of begonias were received from Malmesbury, Wiltshire, which were going off.

An examination of the soil showed great numbers of the white annelids known as *Enchytræidæ*, which are well-known plant-root enemies. They were undoubtedly the cause of the unhealthiness of the begonias sent.

The Leaf-curling Rose Sawfly (*Blennocampa pusilla* Klug.)

A bad case of this was reported in June from Redhill, Surrey. The rose leaves were very bad with curl and it

occurs, the correspondent says, every year. The young leaves when attacked become scorched as if by the sun or frost. They grow out of the leaf curl later, but the growth is always weak and the roses never do well.

Affected leaves were also received on June 26th from Mr. Howgrave-Graham, of Sevenoaks, who had a large number of rose bushes attacked in this way. The curled leaves (Plate XIII.) had been picked off twice quite recently.

An account of this rose pest has already been given. ("The Enemies of the Rose," p. 51, 2nd edition. 1910. Massee and Theobald.)

The Rose Slugworm (*Eriocampa rosæ* Harr.).

This Rose pest, which seems to increase in virulence every year since 1909, was sent from Shepton Mallet, Somerset, by Mr. William Aldridge, who said that " Rose trees were sadly damaged by the hordes of the grubs. No nurserymen or gardeners round here seem to have seen it before."

Another bad attack was reported from Sellindge, near Hythe, by Mr. Henry Hartom. In this case the foliage was completely skeletonized by this so-called Slugworm.

It was also present in great numbers on roses at Little Hadham, Hertfordshire, at Wye in Kent, and specimens were received from the National Rose Growers' Association. It can easily be controlled by spraying with nicotine soap wash, or arsenate of lead, but owing to the disfiguring effects of the latter, the nicotine wash is to be recommended.

The Red Bud Borer of the Rose and Apple (*Clinodiplosis oculiperda* Rubs ?).

Several enquiries have reached me concerning a small red maggot that destroyed the buds of newly grafted roses during the past year. They proved to be the larvæ of Cecidomyidæ, and appear to be identical with the species recorded as attacking newly budded roses in France and Germany, described by Ruebsaamen as *Clinodiplosis oculiperda*.

Exactly the same larvæ were sent me as attacking the buds of apple trees from Hereford.

The first specimens I received came from Woking on August 8th, with the following letter: "Insects on Dog Briars. I am enclosing some rose buds that have been budded this year. I find herein a little grub that gets under the bud and destroys it. It only attacks the Dog Briar. I have had it a few years now, and it rather increases, and each year does considerable damage. Last year I cut off all affected buds and burnt them."

Vuillet writes in the "Revue de Phytophathologie Appliquée," I., p. 112. 1913, that he received in August from near Angers, specimens of *Rosa canina*, which had been budded three weeks, with the buds eaten by small red maggots. The Cecid does not seem to have been noticed before in France, but is known to have caused frequent damage to roses in Germany. The perfect insect emerges in June and on to mid August.

The female lays six to twelve ova in each bud.

The writer recommends woollen or cotton thread for fastening the buds, soaked in turpentine, with napthaline and linseed oil, dried before using.

Grafts near the surface of the soil can easily be covered up.

Leaf Weevils (*Phyllobius*) attacking Roses.

Considerable damage was noticed in May, being done to Roses at Frinsley Green, Surrey, and with the communication sent by Mr. Warren Wynne were specimens of the adult Fever Fly (*Bibio marci*) and numbers of the Leaf Weevils (*Phyllobius maculicornis*). Of course the latter were the culprits, and for a few days the twenty odd beetles sent were placed in a breeding jar with rose shoots, and it was found they attacked both leaf and blossom buds.

They clustered on the buds before they had opened, and gnawed the base and calyx in many cases making large scars and in some eating down to the petals which were exposed. The leaves were eaten in small holes, but the damage was insignificant compared to the damage done to the buds. The beetles did not seem to touch the open blossoms at all.

Phyllobius oblongus was also sent.

Spraying with arsenate of lead where hand collecting cannot be done is the only treatment that will destroy them.

Aphis rumicis on Larkspur.

On July 28th specimens of Larkspur were received with a note that they were being badly damaged by Black Fly, at Henley-on-Thames. The insect proved to be typical *Aphis rumicis* Linnæus.

The shoots and blossom heads were badly disfigured by this so-called Black Fly, or "Collier," which seems to attack nearly all plants.

I have given an account of this Black Aphis in the Board of Agriculture and Fisheries Journal, Vol. XIX.

Gentians attacked by Aphis.

Last year an enquiry reached me from Maidstone concerning an attack of Aphis on Gentians, but none were sent. On August the 9th, 1913, I received the following letter: "Unfortunately I had forgotten until to-day my promise, and on looking at the Gentians I find that the flower is now over and the seed pods have formed, but as there are still some Aphis present I am sending some *Gentiana Tibetica* and *G. cruciata.* The peculiarity which I formerly noticed is not apparent now as the flowers are over, but it may be that the Aphis do not feed on the stem and leaves of the plant, but inside the flower at the base, and at this time they are black in colour, making the flower appear to have a black eye. I notice now they are almost brown."

There were still some blossoms when sent, and in two or three the black aphis was present, giving a very curious aspect to them. In one four insects were present, in the other two only, giving the flowers the appearance of having a black centre.

I was unable to breed out any alatæ, but from the general structural character of the apterous viviparous females, I should say they were the common *Aphis rumicis.* They also fed upon the seed pods and produced numbers of living young on them, and quite ruined those sent me.

Otiorhynchus sp. attacking Begonias.

From Clapham, near Worthing, Sussex, the larvæ of a species of *Otiorhynchus* were received, which were attacking *Begonia polyantha,* and the Persian Cyclamens. As many as five or six grubs were found in each pot, and were destroying

the plants. The beetles on hatching out proved to be the Vine Weevil (*Otiorhynchus sulcatus*). This and the allied Clay-coloured Weevil (*O. picipes*) appear to be very common pot-plant pests.

They lay their eggs in the soil after the plants have been potted as a rule, but it is possible that some larvæ may be carried in the soil, if it has been previously used for similar purposes. Infection, however, usually takes place in the potted plants. These Otiorhynchus Weevils are frequent in green-houses and hot-houses and generally escape detection, owing to their nocturnal habits.

The only safe treatment is to turn the plants out and search for the larvæ or spray the outside of the soil with a fine spray of carbon disulphide, then put back at once into the pots and keep in a dark place for two days. For pot plant pests such as these, and Root Mealy Bug (*Ripersia terrestris*) in palms, etc., this is an excellent treatment, but care must be taken to put the plants in the dark afterwards.

The Chrysanthemum Leaf Miner (*Phytomyzia geniculata* etc.).

This insect was received on June 11th from Crouch End, London, N., where it was much troubling a florist, mining the leaves of his chrysanthemums and marguerites, and so rendering the plants very unsightly, though it did not appear in any way to retard their growth.

Similar damage was also reported on June 18th, from Eltham, to chrysanthemum, and to the same plants from Shedfield, Hampshire.

The last case was due to *Napomyza chrysanthemi* Kowar. The treatment recommended was 1 part nicotine to 200 parts of water, plus a little soap to make it lather.

Experiments with these and other Leaf Miners are recorded in the next section.

Guéndux (La Vie Agricole et Rurale, II., pp. 667, 1913) recommends the following treatment for *Phytomyza geniculata* in chrysanthemums. First pick off the attacked leaves and burn them, then spray the plants, with a one per cent. solution of tobacco juice, and every two weeks afterwards with a five per cent. solution of the same.

Experiments against Leaf Miners.

The effect of various substances against the leaf mining diptera of celery, the *Aclidia heraclei,* and of marguerites and chrysanthemums—*Phytomyza* sp., begun in 1912 was continued in 1913. Nicotine (98 per cent.) was used at the rate of 1 part to 200 of water, and it was found that many larvæ were killed and some pupæ.

A similar row of celery was sprayed with the same, plus 2 ozs. of soap to every two gallons of wash, and the result showed that practically every larva was killed, and as far as could be judged from one portion of the row netted over with muslin, no pupæ hatched out.

Sanders, writing in "The Journal of Economic Entomology," Vol. V., p. 472, 1912, first placed this idea in my mind, but results differed; he found that nicotine solutions, especially "Black Leaf 40," with or without whale-oil soap solution, proved a complete and satisfactory control. He also found that 1 part to 400 of water killed the eggs, larvæ and newly formed pupæ, but that 1 to 200 was necessary to kill pupæ of all ages. Having no "Black Leaf 40," to experiment with, I again tried pure nicotine, 98 per cent. purity alone at 1 to 400, and 1 to 200, in 1913, the results were identical. Then I added the soap and found the same as in 1912.

The reason was very obvious, the soap was found to hold the spray on to the leaf, and thus a greater quantity of the nicotine soaked in through the thin epidermis left by the Celery Miner, and proved fatal to them.

The results in 1913 with Marguerite Fly and a miner on aquilegias was not quite so evident as in the previous year, but none the less a very considerable number of larvæ were destroyed and a second spraying two weeks later nearly cleared the six treated marguerites, and four chrysanthemums of the miners. Later I tried 1 to 100, and this certainly killed all the larvæ but did not kill any puparia, and evidently not the ova, for larvæ hatched out. Then I used 5 to 100, and this seemed to act as a complete control. There is no doubt that the addition of a small quantity of soap, just enough to form a lather, is very desirable.

One point was very noticeable in the rows of celery treated, two sprayed after the rain, the leaves being well soaked, showed the benefit of the nicotine-soap much more than four others sprayed next day when the foliage was dry. One row was treated with paraffin jelly, another with a Pyralin preparation, one with soot water, and one dusted with soot. The row sprayed with paraffin jelly had a hot sun on it, and the result was the foliage was so badly scorched that more harm was done to it than by the fly. The other rows showed no marked benefit from the spray or dust put over them.

These rows were treated when blisters were beginning to show badly in August, and were not treated again, the nicotine soap rows carried a fair crop, the others were never dug, as they all produced stunted, valueless celery.

In spite of the nicotine-soap spraying, the maggot commenced again in October to some extent, but did comparatively little damage.

The results clearly showed that nicotine and soap are a specific against the Celery Fly and to a very considerable extent against the Marguerite Fly—used at 1 in 200; but in the latter case to be effectual it must be 5 in 100, and even then several applications seem necessary whereas one only was necessary in the case of Celery Fly.

It, however, appeared a somewhat costly treatment for celery with nicotine at its present price. It is thus more than ever incumbent for growers to protect their young celery plants before setting out from the first brood of the fly, which starts on the young plants, by keeping them covered by muslin screens during the bright time of the day when the Celery Fly is most active and ovipositing.

For chrysanthemums and marguerites the nicotine remedy can be strongly recommended however.

The Rhododendron Bug (*Stephanitis rhododendri* Horvath).

This beautiful Tingid Bug was first described by Dr. Horvath (Ann. Mus. Hung., III., p. 567, 1905). Distant recorded it first in Britain (Zoologist, Vol. XIV., p. 395) from Fulham, and in 1911 I recorded its presence at Kew (Report on Economic Zoology for year ending September 30th,

1911, p. 118). In this paper I referred to these two records and pointed out that it looked as if this introduced species had taken a firm foothold.

Whilst visiting Woking in May, 1913, I was told of the presence of a "bug" attacking the rhododendrons there, and I investigated the matter.

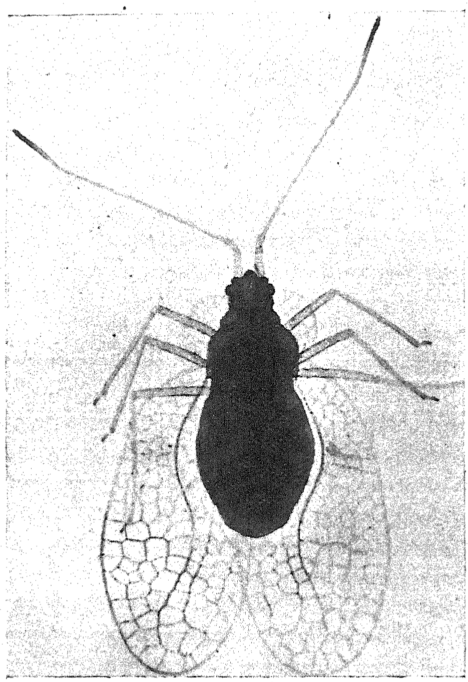


Fig. 40.
Stephanitis rhododendri Horvath ($\times$ 9.

I found that this pretty Tingid which Mr. Distant had kindly named for me *Stephanitis rhododendri* Horvath, was swarming in the district.

In May there was no trace of the insect itself, but its damage to the old leaves was very apparent, and the scars on the sides of their midribs where the eggs are deposited were then very noticeable. From what I could gather it had been

present some little time, and was looked upon as a great nuisance, as it does a considerable amount of damage to the leaves, giving them a very unsightly appearance as well as doing considerable harm to the growth of the plants. (Vide Plate XIV.).

As soon as it made its appearance, thanks to Mr. Slocock, of the noted Old Goldsworthy Nurseries, specimens freshly hatched were sent me in numbers, and from them and many subsequent consignments the adults were bred out in large quantities, but in no breeding jar could I get them to copulate, no ova were laid, and by August all the adults had died off.

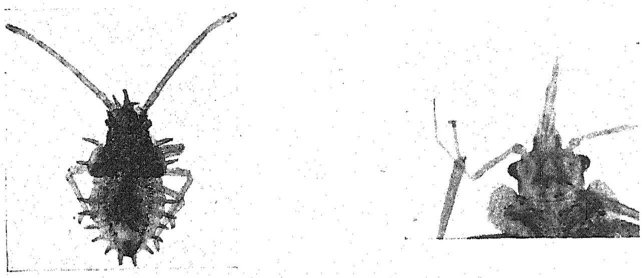


Fig. 41.

Stephanitis rhododendri Horvath.

LARVA AND HEAD, SHOWING PROBOSCIS (greatly enlarged).

Yet in the open they flourish to a remarkable degree. This was probably partly due to the fact that their food supply was stopped for some days as I had to send away for it.

That this Tingid (Fig. 40) is an importation is certain, and Mr. Distant, and Dr. Horvath think that its original home is the Himalayas, the home of the rhododendrons. The genus exists in British India, where is it represented by four species.

Dr. Quanjer, during a recent visit to Wye, told me it was well-known in Holland, and that he thought it had been introduced from Japan.*

A Rhododendron Bug described from America as *Leptobyrsa explanta* Heidermann (Ent. Soc. Wast. Proc., 10,

* *Vide* also Ritsema Bos, Tijdschr, Plantenz, II., 44-45 (1905).

101-108, 1908) seems to me to be identical with this species and will be referred to again later.

On May 24th I received leaves with some fresh hatched young, the egg scars on the sides of the mid-ribs were very distinct and soon became brown scars; as many as eight were counted in one row. The young were almost white with two dark marks on the body, but no prominent spines. They cast their skins in five or six days, and moulted their skins four times as far as I observed, and by July 1st, marked wing buds appeared. At the same time there were many small larvæ (Fig. 41) and larvæ of all stages. The first adults emerged on July 4th, from some fresh specimens sent me from Woking, and another large consignment received on the 17th, also contained many adults and still some small larvæ, which had cleared only recently hatched. The insects work up the bushes and eventually settle on the young leaves when they get more hardened about August and September. They puncture the upper and under sides of the leaves, but especially the latter, and where they puncture the leaf a little drop of clear sap exudes (Fig. 42), a leaf often having hundreds of these drops on its surface. The effect is that the leaves first turn greyish and mottled and then a rusty hue, and later brown. They hang on the bushes and so give a very ugly appearance. (Plate XIV.).

The larvæ keep together in small groups, but as they enter the mature nymph stage (Fig. 43), they spread more over the leaves. The larvæ and nymphæ are rather sedentary.

The adults stick firmly to the foliage and do not seem to feed much, in any case they do not do the same harm to the foliage that the immature forms do. On shaking the bushes, however, some fall down and remain stationary for a time. Their flight is very weak. The adults I kept lived for six weeks and then owing to lack of food died off without copulating or laying any ova.

Felt, in Bulletin 141 of the New York State Museum, refers to Heidemann's species as causing rather serious injury to rhododendrons near New York City, also at Rochester. The curious spined young of this Lace Bug, he says, occur on the under sides of the leaves in May and June,

adults in early July. He describes the unsightly brown spotting accompanied by more or less serious injury to the foliage and refers to the laying of ova in the tissue as an additional source of injury.

In America the Mountain Laurel (*Kalmia latifolia*), Great Laurel (*Rhododendron maximum*) are attacked along the Atlantic slope, from North Carolina northwards to at least New York State.

The ova are cylindrical and oval, pale yellow, 0.4 to 0.5 mm. long. It winters as ova in the epidermis of the mid rib, or its sides, distinct scars being produced. They hatch in May. The young are white and transparent, with no spines. Then they become greenish white, moult in four to five days, and spines appear.

This is just as we find occurs in this country.

I also found two specimens of this Tingid at Sevenoaks. As it can flourish so well in this country there is no reason that other importations may not. A look out should consequently be kept on pear trees for *Tingis pyri*, which is very harmful in Portugal, Russia and parts of South Europe.

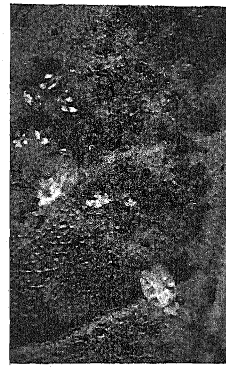


Fig. 42.
Adults and Group of Nymphs on Leaf, Showing Damaged Spots.
(nat. size.)

The Rhododendron Bug has been controlled at Woking by spraying with paraffin emulsion, but two or three applications are necessary, as they hatch our irregularly.

Description.—

The Adult. (Fig. 40) Female; body oval, in male elongate, shiny black. Wing-like expansions of pronotum and wings pale yellowish-white to white, almost transparent, with net-like veins as shown in the photo, with well defined brown marks near the middle. Apex of female rounded, in the male with two strong, curved claspers.

Antennæ long, the first segment twice as long as the second, third the longest, about four times as long as the fourth, pale creamy-white, except the apex of the fourth, which is black ; hairy. Legs pale ; rather long. Rostrum

pale, reaching to the second pair of legs, apex dark. There are three small white frontal spines. Veins of the wings with short thorn-like spines.

Length.—3.5 to 4 mm.

Nymph.—Yellowish-white, with some yellow areas and brown markings as follows:—At base and apex of the wing pads and the abdomen in the middle and the bases of the legs. All the spines dark-brown; five large ones on the head; one large one on each side of the pronotum; two on the mesonotum and one in the middle; a single one on the

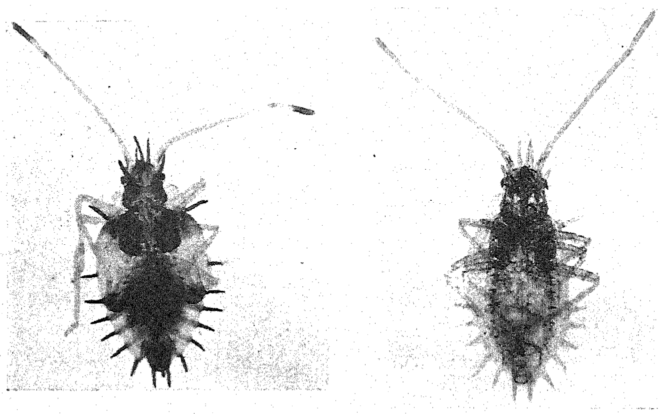


Fig. 43.
THE NYMPH IN TWO STAGES.

middle of the first, third, fourth and sixth abdominal segments, one at the apex of each wing pad; four on each side of the abdomen, somewhat smaller, and two terminal ones. Antennæ as long or longer than the body; first segment about one and a half times the second, pale; apex of third and half the fourth dark.

Length.—3 to 3.5 mm.

The Swallow Tail Moth (*Uropteryx sambucaria* Linn.).

Caterpillars of this moth (Plate XV.) were received in September from St. Helens, Lancashire, with a note stating

that they were badly damaging the ivy there, and two similar enquiries were received from Hertfordshire, The normal food plants of the larvæ of the Swallow Tail Moth (*Uropteryx sambucaria* Linn.) are oak, ivy, elder and bramble. In March, 1911, I recorded them as feeding on green apple buds, and doing no little damage, and also eating the buds of cherries and the blossoms off peaches on walls at Mortimer, Berkshire (Rep. Eco. Zool., year ending September 30th, 1911, pp. 32 and 33, pl. xi.).

In the previous year it was recorded as attacking roses (Rep. Eco. Zool., year ending September 30th, 1910, p. 126). This pretty moth is often very common in its caterpillar state on ivy, which I have seen on many occasions quite defoliated by it when growing up houses and have had on two occasions to make use of Arsenate of lead to kill them off owing to the damage they were doing.

The Black Aphis (*Aphis rumicis*) on Euonymus.

A vast amount of this Aphis was present in the London suburbs in 1912 and 1913, the ornamental evergreen Euonymus so largely used in suburban gardens was smothered with it in many parts.

I am not aware of it, however, having been noticed in large numbers in the winter before. Mr. G. C. Gough, of the Board of Agriculture, sent me a box full of this insect in February, saying it was very abundant, but he had not noticed it at this time of year before.

In March these became winged and the alate females went to some docks placed in the breeding jar and produced large colonies and later were transferred to poppies and then to beetroots. It thus appears that this Aphis can winter in the adult stage as well as in the egg stage.

Others were received from Fowey, Cornwall, in early March, where they were also swarming on a Golden Euonymus.

Aphides on the Roots of Plants.

A number of Aphides have been received from the roots of plants during the past year.

In January an enquiry was received from Mr. John Williamson of the John Innes Institute, saying: "We are

troubled with a Woolly Aphis on the roots of primulas and auriculas. There is also a lot in the ground on the roots of various weeds, such as dandelion, docks and grasses. I shall be very pleased to know the best means of getting rid of them.'

Later he wrote: "The only one I have noticed here with ants is on the roots of the Leopard's Bane (*Doronicum plantagineum*)."

Later Mr. Morley Crane sent me these Aphides (17.1.13), saying: "They are now scarce on the roots. In late summer

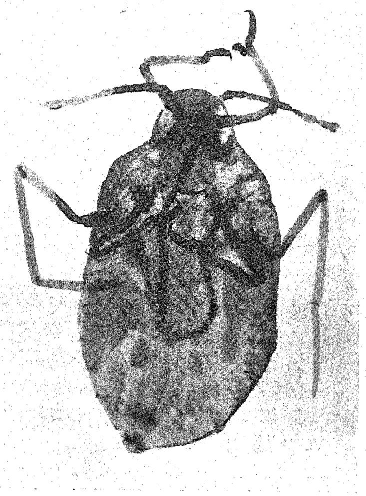


Fig. 44.
Trama radicis Kaltenbach, Apterous Viviparous Female.

they were very numerous and ants with them. At present there are no ants with them. I am anxious to know about them."

These proved to belong to two species known as *Trama troglodytes* Heyden, and *Trama radicis* Kaltenbach (Fig. 44). These plant lice are essentially ground insects and now and then occur in large numbers.

In December Mr. Jemmett found great numbers on artichoke roots at Wye, and I have before had them sent feeding upon the same plant.

This genus of Aphides can at once be told from all others by the fact that its hind tarsi are very long, approaching the length of the tibiæ. They are usually creamy-white or grey, but vary very much, some being greenish, others dull purplish. Occasionally winged females appear, but what happens to them we do not know. Alate females hatched out in January, 1914.

These Aphides are frequently to be found in ants' nests, and are looked upon as being truly myrmecophilous. Nevertheless they are to be found in numbers far from formicaries,

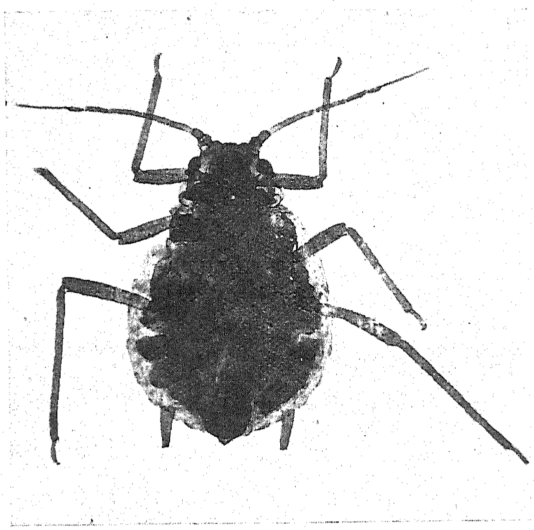


Fig. 45.

Aphis subterraneus Wlk. APHEROUS VIVIPAROUS FEMALE.

but even then they are largely attended by ants. They are often very mealy, and when the ants approach them, they salute them with their hind legs, vibrating them in the air.

They reproduce comparatively slowly, but as they live a considerable time very large colonies are formed. A full account of these insects will be found in my "Monograph of Myrmecophilous Aphides," shortly to be published by the Entomological Society of London.

Another subterranean form was received from Mr. W. Dannreuther on March 17th, forming white fluffy patches in the soil on the roots of grasses and weeds in his fruit plantations at Battle, Sussex. These proved to be *Brysocrypta lactucaria* Passerini, (Fig. 46) which frequently occurs on the roots of lettuces, etc., in gardens, and which occasionally does some damage, and this was accompanied by *Aphis subterranea* Walker (Fig. 45).

A bad attack of root Aphides upon potted marguerites was received from Burr Farm Nurseries, at Bexley Heath, on April 8th, 1913.

The roots of the plants, which were not growing out well, were simply smothered with Aphides accompanied by a whitish meal and wool. Not only were the plant lice fixed to the roots and rootlets, but they were in cells or nests in the soil in great numbers, and were reproducing with considerable rapidity.

An examination showed them to be the *Brysocrypta lactucaria* of Passerini. The plants were kept and gradually went back under the attack, two dying right off. The Aphides lived on in the soil for some six weeks, and then on May 22nd commenced to give rise to an alate brood.

Others have been received from Lincoln, Halifax and Tiverton.

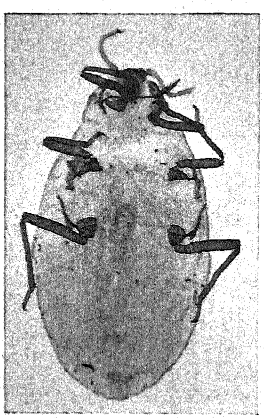


Fig. 46.
Brysocrypta lactucaria Passerini.

Although there are many species of subterranean Aphides, with the exception of the ground form of the Woolly Aphis (*Eriosoma lanigera*) and the Currant Root Louse (*Schizoneura ulmi-fodiens*), few seem to do any harm in these islands. But on the Continent, especially in Russia and Hungary, such species as *Pentaphis marginalis*, *P. trivialis* and *Schizoneura corni*, all of which occur in Britain, do a great deal of damage to corn crops, etc.

I have, however, known carrots to be badly damaged by Koch's *Aphis carrotæ*, or as it is now called *Hyalopterus carrotæ*, the insects which in some localities swarm in the soil, attack the carrots anywhere below ground and cause them to split.

I have found soil laden with *Brysocrypta lactucaria* after lettuces, and it was soon cleared by a single application of Vaporite, but this species was not noticed to have caused any marked damage, as it did in the case of pot plants recorded on page 306.

OTHER INSECTS ATTACKING ORNAMENTAL PLANTS.

Mealy Bug (*Dactylopius longispinus* Targ. Toz.).

Specimens of Poinsettia leaves attacked by Mealy Bug (*Dactylopius longispinus*) were received from Ashford in September. Where the Coccids were the leaves showed discoloration and many of them died off.

Rose Leaf Hoppers (*Typhlocyba rosæ* Linnæus).

Two cases of damage to rose leaves by the Leaf Hopper (*Typhlocyba rosæ*) were received in July from Kingston and Weybridge. The marked mottling or marbling of the foliage was very marked in both cases.

Cinerarias attacked by Leaf Miners.

A bad case of the Cineraria Leaf Miner was received in February, the large leaves even flagging under their attack. Nicotine wash was tried and certainly destroyed the majority of the larvæ.

ANIMALS INJURIOUS TO FOREST TREES.

Helix caperata damaging Conifers

In May Mr. Wm. McGowan, of Panton House, Wragby, sent some snails which had killed some hundreds of Douglas Firs. They had eaten and were eating the bark off in rings.

The snails sent were *Helix caperata*. On visiting a small plantation belonging to the College in June, I noticed many of these snails on the heads of the Spruce, and many on some Firs. They were found to be working in a similar manner, gnawing rings round the top tender growth, and also later I found them gnawing the buds.

I could find none on trees more than six feet high, and few on trees over five foot. As a rule only one or two were present and these did little harm, but when many were on the trees they looked decidedly unkindly, but none have died. I am not aware of this damage having been noticed before.

OSIER PESTS.

Mr. Hutchinson, of the Midland Agricultural and Dairy College, wrote sending beetles attacking osiers in Derbyshire, and asked for information concerning the chief insect pests found in osier beds, and sent the following information :—

(1) "I have already visited 1,000 acres of willows and in all cases Aphis attacks the rods in summer. Frequently the attack is so severe that the plants are killed outright, and growth is always seriously interfered with.

(2) "Galls are also very common on the leaves, a bed I saw near Gainsborough had suffered so much that the leaves and rods were bent with the weight.

(3) "'Button Top' is common. In this case the terminal bud or apical growing point, is attacked during the year, the young leaves curl up together and enclose from three to five

small reddish grubs. Rods attacked in this way shoot out lower down the stem and are of considerably less value than straight rods.

(4) " At the base of the rods very frequently one can find large numbers of shot-holes with grubs inside. The tits go for these and make the holes larger. This attack means that about one foot of the thick end of the rod is valueless.

(5) " In rods which have been allowed to stand three to four years, a maggot about one inch long is sometimes found

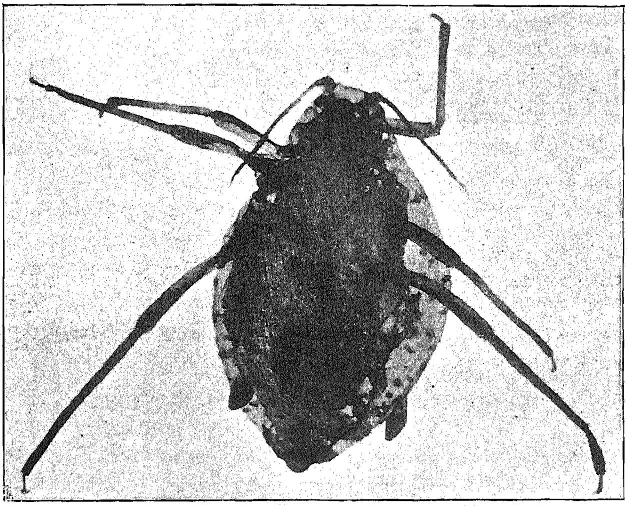


Fig. 47.

APTEROUS FEMALE OF *Melanoxantherium salicis* Linnæus.
(Magnified sixteen times.)

working in the pith. In a willow holt I visited near Newark, two in every five rods were attacked.

(6) " Next to the Aphides the most destructive pest is the Willow Beetle. Only soft rods are attacked as a rule, and the insects completely destroy the crop of the year. They do not, however, seem to kill the plant like Aphis. I have seen hundreds on a single plant. Last Friday I was in the Retford district and saw great destruction had been committed by it on some varieties. There were none on the rods when I

saw them, but I found thousands clustered together under the bark of some old willows growing on the outskirts. I also found some in dead stumps in a hedgerow. This crop would have been worth £14 to £15 per acre, but for this attack."

The following report on Osier insects has been sent to Mr. Hutchinson:

It does not include a list of osier insects, which are very numerous, but a short precis of those that I have either found doing harm, or which have been sent to me as destructive, and those to which he refers.

I have not included here an account of the Willow Aphides, all of which will feed upon the osiers, as a paper was given on them in my last report.*

The most destructive Aphides in osier beds, however, I may mention are the following:—

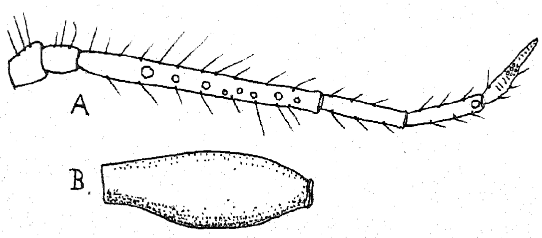


Fig. 48.
Melanoxantherium salicis Linn.
A. Apterous viviparous female antenna and cornicle B.

Destructive Osier Aphides.

(1) *Aphis saliceti* Kaltenbach.
On the leaves of Salix album, S. cinerea, S. capreæ, and S. viminalis. Clusters upon the young tips and kills them, and also under the leaves. Apterous form, bright yellowish-green to deep green. Often very harmful in osier beds. (Plate XVI.)

(2) *Cavariella* (*Siphocoryne*) *capreæ* Fabricius.
Very common on all Salix, feeding on the tips of the shoots and under the leaves. It migrates in early

* Report on Economic Zoology for the year ending September 30th 1912, pp. 81-99.

summer to Umbelliferæ. Apterous female bright yellowish green, the cornicles are somewhat clavate, and it can at once be told by having a marked supra caudal process. (Plate XVII.)

(3) *Melanoxantherium salicis* Linnæus.

Often occurs in dense masses on osiers and is also found on *Salix viminalis* and *S. capreæ*. The colonies often number some thousands of individuals, I have found them two feet long on osiers, literally covering the rods. A large sooty black to dark grey species, with orange legs, antennæ and cornicles; the body with a pale median dorsal line and pale grey patches on the segments. The cornicles are skittle-shaped. (Figs. 47 and 48).

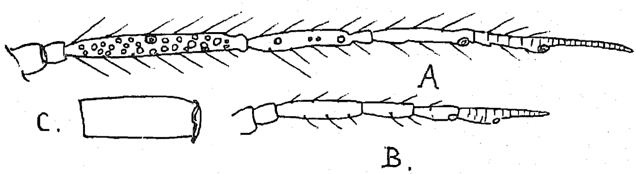


Fig. 49.

Pterocomma pilosa Buckton.

A. Antenna alate female. B. of apterous female,

C. Cornicle of apterous female.

(4) *Pterocomma pilosa* Buckton.

Now and then on osiers, but usually on willows. The apterous female is green spotted and marked with darker green and covered with fine hairs; antennæ short and the legs stout and hairy. Often in large colonies on the leaves and shoots and bark. Cornicles moderately long, grey and cylindrical. (Fig. 49).

(5) *Lachnus viminalis* Fonscolombe.

A large species with no prominent cornicles. Globular, dark brown, with fine grey hairs. Abdomen with a horn-like process in the middle and several rows of dark spots. Occurs in large colonies and secretes much honey dew, which kills the leaves upon which it falls. Usually on the wood.

The Willow Beetle (*Phratora vitellinæ* Kirby).

This is one of the two common Willow Beetles and one which often does untold harm. It feeds upon all Salix, but is especially harmful to osiers. Both adults and larvæ are destructive.

The beetle is about one-sixth of an inch long, of a deep metallic bluish-black colour with bronzy reflections and sometimes of a greenish lustre. The elytra have regular longitudinal rows of punctures, a character by which it can be told from the allied *Phratora vulgatissima* of Linnæus, which has the striæ on the elytra irregular.

These beetles hibernate in the adult stage, under the bark of trees, in hollow stumps, amongst rotten wood and under rubbish near the osier beds. They often collect together to hibernate in dense masses, some thousands together and there they remain in a dormant state until the spring. They then leave their shelter and go to the osiers to feed and breed. These Willow Beetles also occur in numbers on Poplars and, according to Gillandus (Forest Entomology, p. 64), they are found especially under the rough bark of the Ontario Poplar, and the excrescences on the ash caused by the canker fungus *Nectria ditissima*. The female lays her eggs in small groups on the under side of the leaves. They are placed close together and vary in number from six to twelve.

The larvæ on hatching devour the lower and middle tissue of the leaves, skeletonizing them; the damaged foliage turns dirty greyish-brown. The larvæ are more or less gregarious and feed together in a very characteristic manner, keeping in single lines close to one another, more or less in straight lines. They are of a dirty greyish to yellowish-grey colour, with dark spots and six legs in front.

When mature they fall to the ground and pupate in the soil. There are two broods during the year, the spring beetles produce a brood of larvæ that mature in the summer, and then a brood of beetles that oviposit again and their larvæ give rise to the brood that hibernates.

Not only do the larvæ damage the leaves, but the adult beetles do even more damage, for they attack the young rods, eating the tender parts, especially the growing points, and thus stunt the length of the rods. They also cause endless harm to

the second year rods by working in a very similar way, the rods throwing out a mass of small lateral branches instead of growing upwards.

The Allied Willow Beetle (*Phratora vulgatissima* Linn.).

This is the species sent in such large numbers by Mr. Hutchinson, referred to in his letter as the Willow Beetle of the Midlands. It differs from the former in being a rich, deep metallic blue, and by having the punctured striæ of the elytra irregular instead of regular as in the former species. It has exactly the same life-cycle and habits, and causes very similar damage, both in the adult and larval stages.

The Willow Galerucellas (*Galerucella lineola* Fabr., and *G. tenella* Linn.).

The species *Galerucella lineola* of Fabricius occurs in some districts in large numbers in osier beds, and both adults and larvæ do a great deal of harm. It occurs on willows of many kinds, but especially on *Salix viminalis*, and also occurs on the hazel and alder.

The beetle is of a dull yellowish-brown colour, with black on the thorax, the vertex of the head and the abdomen, except at the apex. The thorax is closely pubescent. In some the elytra have dark marks, but as a rule they are uniform yellowish-brown. The legs are yellow-brown. In size it is 4-5 mm.

An allied species occurs on osiers, the *G. tenella* of Linnæus, which is only from 2¾-3½ mm., but does not appear to have done any harm. It is recorded nevertheless as destructive to strawberries.

G. lineola is recorded by Fowler from Repton, Burton-on-Trent, Greenhithe, Woking, Brentford, Hastings, Portsmouth district, Glanvilles Wootton, Exeter, Bristol, Swansea, Wicken Fen, Cheshire, Ireland near Waterford and Armagh; MacDougal records it from Essex, Warwickshire, Gloucester, Somerset and Kildare. I have received it from Worcestershire, Hunts and Kent.

G. tenella is locally common, especially in the London, Southern and Midland districts. It is also found in Yorkshire,

Cheshire, Northumberland, Durham, Cumberland, Scotland, Solway, Tweed and Forth districts, and at Armagh in Ireland (Fowler).

The damage done by *G. lineola* is often very great, the beetles eat the buds and young leaves as they open. Later old leaves are eaten. As a rule the lower epidermis and mesophyll are eaten in patches, the upper skin being left, some are skeletonized and the delicate shoots are gnawed. The beetles lay their orange-yellow eggs in clusters, standing erect from the surface of the leaf, on its lower side. They may be found from April to August and hatch in twenty to twenty-four days. The larvæ devour the leaves from beneath and live for about five weeks and then pass to the soil, where they pupate, this stage lasting ten days.

These different stages may all be found at once from the end of April to mid-August. The adults hibernate in the osier stools, under willow bark, and in hollow stems, and amongst rubbish of all kinds.

The larvæ are of a yellow-black hue, with black spots and patches, the under surface yellow with dark patches and dots, laterally there are tubercles. Length, half an inch.

The Osier and Willow Flea Beetle (*Crepidodera aurata* Marsh).

This flea beetle may be found in most osier beds and frequently does a good deal of damage. The beetles eat holes in the leaves, often quite skeletonizing them. It also feeds on willows and the poplar. It occurs all over England and is replaced in Scotland by an allied species *Crepidodera smaragdinæ* Foudi, but no damage has been recorded as being caused by the latter. Fowler records it as feeding also on the aspen.

C. aurata often occurs in vast numbers in the South and South-east of England, and I have found it doing considerable damage near St. Neots in Huntingdonshire. The beetles occur in early spring, in small numbers, compared to the later brood. At that time they gnaw the buds as well as later devour the leaves, the terminal bud being often ruined. The beetle varies from 1½-3 mm. long; it is a very pretty species, the head and thorax being a brilliant coppery-red,

the elytra shiny golden-green, the legs red and black, in some the black predominates, in others the red. Those with all dark legs are said by some authorities to be a distinct species—*C. nigricoxis* All.

I have found the beetles hibernating in the "stools," and amongst fallen leaves, and under the bark of trees near the osier beds. Their skipping movements are very characteristic.

The Osier and Willow Weevil (*Cryptorhynchus lapathi* Linn.)

The larvæ and adults of this weevil frequently cause considerable damage to osiers. It is not only common in Europe, but also occurs in America. It appears to be rare in the North of England and Scotland, but is very common in the South and West.

The larvæ tunnel under the bark and make their way into the pith and do endless damage to young stems, which readily break off.

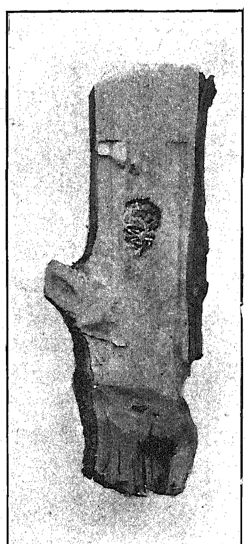


Fig. 51.
DAMAGE DONE BY THE OSIER AND WILLOW WEEVIL.

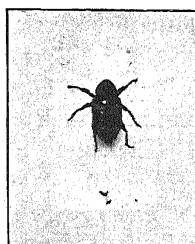


Fig. 50.
THE WILLOW WEEVIL (*Cryptorhynchus lapathi* Linn.)

The beetles also do harm by gnawing the bark and sap-wood of the young shoots. It attacks also poplars, alders and birch. It is said to prefer young alders of four to six years of age, but I have found that where alders grow with willows it seldom attacks the former.

The beetle (Fig. 50) is very marked; it is 8 mm. long, blackish-brown, the apex of the elytra with a broad creamy-white area, and there is a paler band in the middle; the stout rostrum is folded underneath

the body. It appears in the end of April and continues until June. The beetles then lay their eggs and in two weeks the larvæ hatch and eat their way into the shoots. They are creamy-white and footless, with a wrinkled skin, not quite half an inch long. The galleries they make are filled up with wood chips (Fig. 51) and these are passed out also and fall around the stools, a sure sign of the weevil attack. They mature by autumn and the beetles come out and hibernate in holes in the plants or in the stools, etc. Some larvæ, however, evidently live through the winter in the osiers, etc.

Damaged rods and stems should be cut down and burnt, and stools where attack has been should be covered with lime in winter.

If taken in time and the affected stools have the attacked matter cut out and burnt, the beetle cannot spread to any injurious extent.

GALLS ON WILLOW LEAVES.

A.—Those caused by Sawflies.

Several Sawflies belonging to the *Nematinæ* form galls on osier and willow leaves, and may do harm if present in large numbers, such as is described by Mr. Hutchinson at Newark.

The only one I have ever seen in great number is

Pontania gallicola Stephens.

This sawfly also known as *Nematus gallicola* and *Nematus vallisnerii* Hartig, is found on all varieties of Salix.

The galls are found often all over the leaves and sometimes just at the top of the petiole. They are at first green, oval in shape, and then become reddish in colour, and show on both sides of the leaves. On cutting a gall open one finds a cavity within, and a small sawfly larva.

There are two broods during the year. When the larva is mature it eats its way out of the gall and falls to the ground, leaving a prominent round hole in the gall. The first brood of Sawflies appear in May, the second early in August.

Another globular gall is formed in the leaves due to *Pontania salicis* Christ, on *Salix capreæ*, on the lower side of the leaf only, and seldom more than one or two on each leaf. This Sawfly occurs in May.

Another very similar gall occurs on the leaves of *Salix viminalis*, due to *Pontania bella*, André, the adult of which occurs in June.

Others occur, but are of little economic importance.

B.—Those caused by Midge Larvæ (Cecidomyiadæ.)

The larvæ of several Midges or *Cecidomyiadæ*, a family of the diptera, form galls on the osiers and willows. One of the commonest is the

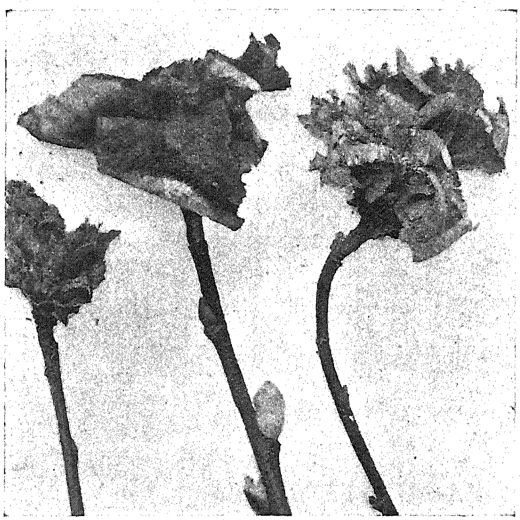


Fig. 52.
ROSE GALLS CAUSED BY *Rhabdophaga rosaria* Lw.

Rose or Button Gall (*Rhabdophaga rosaria* Lw.)

This midge may be found in all parts of Britain and attacks several kinds of *Salix*. The galls (Fig. 52) take the form of a rough rosette of leaves at the tips of the shoots, due to arrested growth caused by the maggots of the small fly *Rhabdophaga rosaria* of Loew. The midge is only 8 mm. in wing expanse the female has a grey, hairy thorax, pink abdomen, ending in a telescopic ovipositor, the lower surface fine-flesh colour, with fine grey hairs. The long thin legs are grey, the

tarsi being reddish. The wings are grey, with darker grey veins, and the halteres pallid. The male is all grey, the thorax being darker than the abdomen and hairy. The fly appears in May, and the female lays her eggs in the terminal shoots and by June the reddish larvæ have caused the curious rosette to appear, and there many of them remain in the dried gall all through the winter and pupate in the spring. Some, however, fall to earth. These galls are very noticeable in the winter months.

Another common species is the

Willow Twig Midge (*Rhabdophaga salicis* Schrank).

This also occurs on almost all willows and osiers. The gall is a woody mass, formed on the twigs between the internodes, and is caused by the maggots of this fly feeding upon the pith, causing the woody cells surrounding them to swell up.

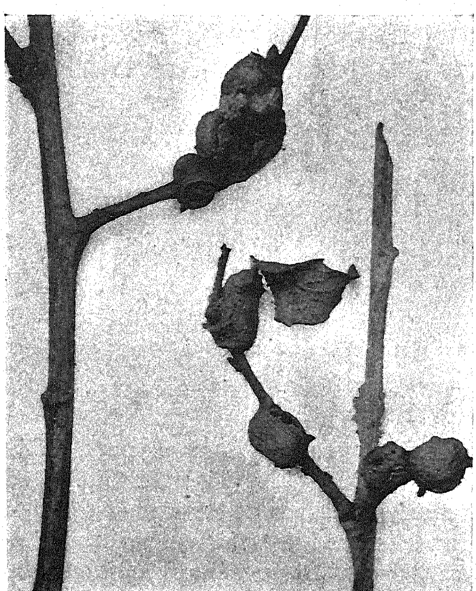


Fig. 53.
GALLS CAUSED BY *Rhabdophaga salicis* Schrank.

Sometimes these galls are two inches long and an inch in diameter. On cutting them open we find from ten to forty yellow to pale orange larvæ within.

The adult midge appears in May and places her ova in the twigs of the previous year's shoots. The female is 6 mm. in wing expanse, with a dark grey thorax with two yellowish lines, the abdomen dark greyish to brown above, paler, often

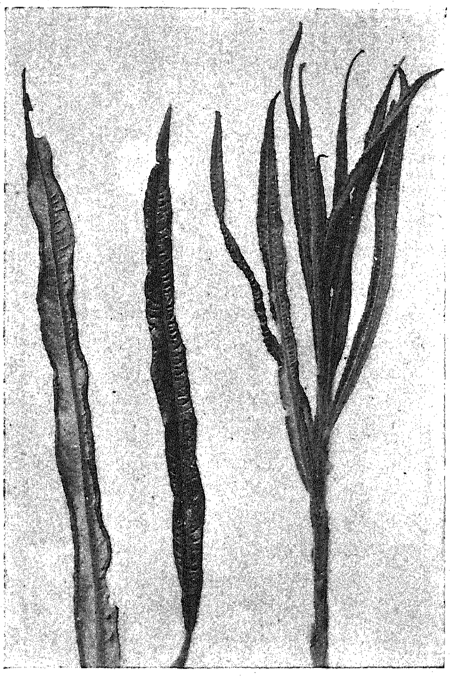


Fig. 54.
LEAVES OF SALIX, EDGE ROLLED BY *Dasyneura marginemtorquens.*

red below. The transparent wings are red at their base and the long legs are grey. The larvæ live in the galls all through the winter and pupate in the spring in the galls, the puparia being light yellow, the flies escaping from the galls in May.

Another common species causes the edges of the leaves to roll up. This is *Dasyneura marginemtorquens.*

Dasyneura marginemtorquens Bremi.

It is especially common on the osier and forms rolled-up galls on the edge or edges of the leaves, often from one end to the other, the sides roll up towards the mid rib and assume all manner of shades, green, pinky-purple, and brown. They may be seen from June to October. The larvæ pupate in the galls. It, however, does little harm in osier beds.

The Willow Wood Midge (*Rhabdophaga saliciperda* Duf.).

This is the species referred to by Mr. Hutchinson as causing shot holes in the rods. It attacks Salix of all kinds and all ages.

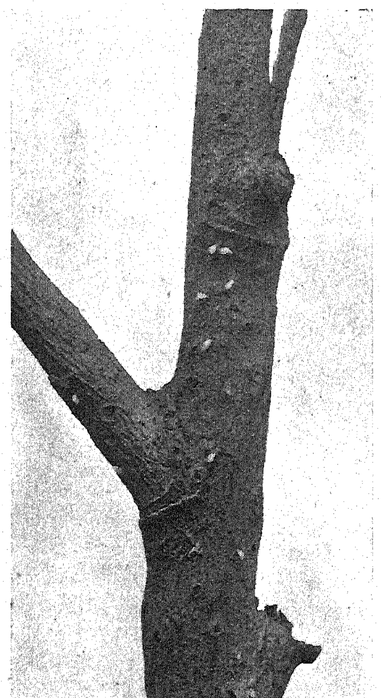


Fig. 55.
WILLOW STEM SHOWING PUPA CASES AFTER HATCHING OF THE WILLOW WOOD MIDGE.

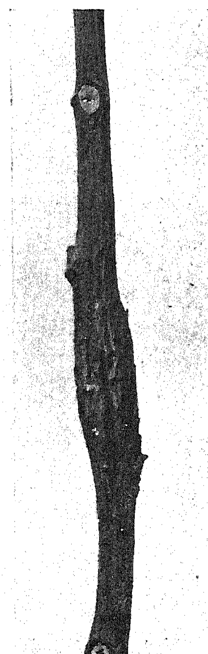


Fig. 56.
YOUNG WILLOW SHOOT ATTACKED BY WILLOW WOOD MIDGE.

The female lays her eggs for choice in stems of two years' growth or more, with twigs up to three inches in diameter. The ova are laid in chains on the rind or bark and the larvæ at once bore into it and then they make irregular galleries. It is said by MacDougall that it is possible that the larvæ may not need to bore their way in, as the activity of the cambium with its wood formation, may be sufficient to enclose them.

Where the larvæ are, a swelling usually takes place of a spindle-shaped nature, and later this splits. (Fig. 56).

The larvæ live in the wood, tunnelling about from June to the following May or June. Before they pupate the larvæ move to the surface, and pupation takes place under a very thin layer, which the pupa can easily break through by means of its two horns. The empty skins of the pupæ may be found projecting from the holes as shown in the photograph (Fig. 55). Later when these get removed the bark is seen to be riddled with small shot holes.

The fly is about 4 mm. in wing expanse, head and thorax black, with black hairs ; the wings milky-white with whitish hairs.

The yellow pupæ have two well marked horns at the base of the antennæ.

MacDougall records this from the White Poplar as well as from various Salix.

Smearing the attacked places over with tar seen by the swellings will prevent the delicate flies from emerging, although the pupæ may partly force their way out.

Another species, *Rhabdophaga heterobia* Loew, also attacks Salix, but is seldom of economic importance. In 1904 MacDougall, however, reports that the damage done by it was great. It produces small rosette-like galls on the tips of the shoots of *Salix cineria* and *S. triandra* where it pupates. It also infests the male catkins of *Salix amygdalina.* The adult is dusky-brown with a yellow venter to the abdomen.

The Osier or Hornet Clearwing (*Trochilium bembeciformis* Hubner).

This is probably the insect referred to by Mr. Hutchinson, as a white grub an inch long, working in the pith at Newark, where two in every five rods were attacked.

I have found this insect on several occasions in osiers, but it usually attacks the Goat Willow (*Salix capreæ*). The larvæ (Fig. 57), are usually found in the base of the stems. They are white, with a brown head and taper somewhat posterially, the small legs are dark brown. Holes are formed in the stems, where the pupæ, which are bright chesnut brown, force their way out before the adults emerge.

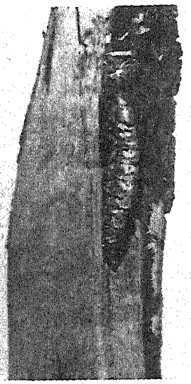


Fig. 57.
LARVA OF HORNET CLEARWING *in Situ.*

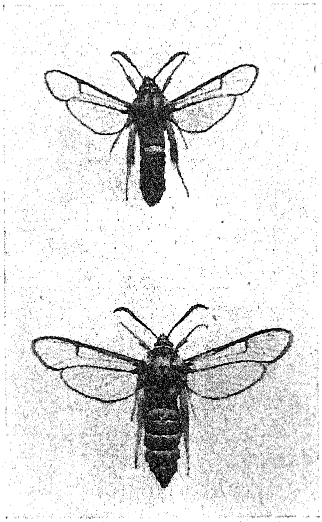


Fig. 58.
OSIER OR HORNET CLEARWING
(*Trochilium bembeciformis* Hubner.)
Male and female.

The larvæ appear to take sometimes two years to develop. They form galleries in the wood or in the pith centre of small stems.

The moth (Fig. 58) has a wing expanse of 1 to 1½ inches. The body is dark brown with yellow bands, the head and thorax dark brown, the legs orange to orange-brown, and the transparent wings have the costal edge dark orange-brown, and the veins dark brown.

It is common in some districts, but is distinctly local.

The moth appears in June.

The Osier Depressaria (*Depressaria conterminella* Zeller).

The larvæ of this Tineid Moth are very frequent in osier beds. The larvæ spin the top leaves together in a characteristic manner shown in the photograph (Fig. 59). These deformed leading shoots are noticeable in May and June, and in them is found the larva or small caterpillar. It is sometimes so abundant that it becomes very injurious to osier rods in all parts of the country.

Fig. 59.
DAMAGE DUE TO THE OSIER *Depressaria*.

Some Notes on the Pine Sawfly (*Lophyrus pini* Linn.).

In Kent there was a great abundance of the second brood of the Pine Sawfly (*Lophyrus pini* Linnæus), in the autumn of 1913. The life cycle of this forest pest is very varied. In some seasons there appears to be only a single brood, in others there are two broods.

In September last very large colonies were found near and in Wye, some pines being quite defoliated by them. One colony contained one hundred and ten larvæ, another sixty. The larvæ were not only feeding on that year's growth, but all over the young trees.

As a rule they occurred at the borders of the plantations, but I found some far in. Young trees were mainly attacked.

Fig. 60.
COCOONS OF PINE SAWFLY MADE IN OCTOBER ON SHOOTS.

These larvæ commenced to pupate on October 2nd, and the last on October 24th.

The cocoons were mainly spun on and amongst the needles, but in the breeding jars many were spun up on the muslin covers. In the open I found many on the trees, usually in clusters (Fig. 60), a few on the stems, and some amongst weeds and on the soil below. The first Sawflies emerged

on April 8th, 1914, and they kept on coming out irregularly, until June 29th. The first two to hatch were a male and a female. Also the second pair on April 12th, then a series of twenty-five females emerged up to the 19th. The females are extremely sluggish, but in the sun the dark males were quite active on the wing. These soon copulated and the female oviposited a few days later. This is very early appearance, the beginning to middle of May being the usual time, but they are so erratic that one never knows when they will hatch. Last year I took adults the first week in May, again on June 14th, and again on August 7th. Normally there are two broods, but the pupæ of the first brood may only partially hatch in July and August, some remain over the winter, and form the first brood of the following year, sometimes hatching at the same time as those from the second brood, sometimes sooner, and in one lot I kept, considerably later.

From those I have kept I have not found that the males come out before the females as seems usually recorded. Moreover, the males died off very rapidly, whereas the females lived some four weeks. The larvæ are usually noticeable at the end of May and in June, and by the end of the latter month and in July they are ready to pupate. These cocoons are normally spun amongst the needles, but it is said that those of the second brood are spun mainly amongst the fallen needles, moss and heather beneath the trees. Often they may be found in masses on the ground, and in them the larvæ remain until the spring, when they pupate. Quite ninety per cent. of those I kept and watched in the open last autumn, however, made their cocoons amongst the needles, as shown in the photograph reproduced here.

For further information concerning this forest pest the reader is referred to my second report on Economic Zoology.*

The Elm Bark Beetle (*Scolytus destructor* Oliv.).

This insect was sent on August 11th from Farnham, with a note that the Elm trees were attacked by the boring insect sent. The writer stated that he had lately noticed that the

* Second Report on Economic Zoology (British Museum Nat. Hist.), pp. 165-169. 1904.

trees which were attacked seem to exude moisture which attracts a quantity of flies and wasps.

The damage was due to the Elm Bark Beetle (*Scolytus destructor* Oliv.), a well-known elm tree enemy. I have already dealt with this pest and its treatment (Report on Economic Zoology for the year ending September 30th, 1911, pp. 121-127, Pl. XXXIV.)

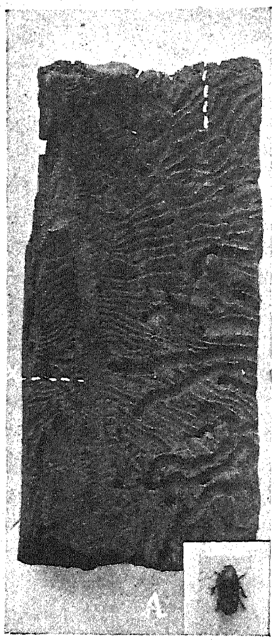


Fig. 61.
THE ELM BARK BEETLE
(*Scolytus destructor* Oliv.).
A. Damage.
B. Adult (slightly enlarged).
X. Mother gallery.
X1. Larval galleries.

The Holly Leaf Miner
(*Chromatomyia ilicis* Curtis).

From Woking, on April 24th, information was sought concerning a very bad attack of the Leaf Blister Fly of Holly, the *Chromatomyia ilicis* Curtis, the *Phytomyza ilicis* Kaltenbach.

This leaf mining dipteron is very widely spread over Britain and sometimes occurs in enormous numbers, quite ruining the holly leaves. In 1911 I saw a very bad attack at Shanklin, Isle of Wight, every hedge and tree having the leaves completely ruined and dead from the mining of the larvæ.

Although holly will stand a good deal of rough usage they cannot resist a persistent attack of the insect, and it is noticeable that very often when once attacked the disease persists and gradually increases, and this in spite of the fact that one finds many dead puparia, evidently killed by some parasite, which I have been unable to breed out.

Practically all varieties of holly suffer alike.

The mining done by the larva is at first narrow, but by degrees they form large blisters, often covering the whole leaf, sometimes these blisters are pale green, at others yellow,

later brown, and some have dull reddish borders and patches.

The mature insect hatches in June and goes on appearing right through the month.

The fly has a wing expanse of 3.5 to 4 mm. Its colour is dull blackish, the abdomen having narrow pale transverse bands, whilst below it is pale dull yellowish, but some specimens are dark all over; thorax and body are hairy. The eyes are deep brownish-red; the transparent wings have black veins, and the halters are dull white.

The flies are very active and lay their eggs soon after hatching, placing them beneath the leaf, usually on or near the mid-rib, but now and then elsewhere. The eggs hatch in from six to ten days and the young maggots at once bore into the tissue, frequently attacking the mid-rib first. Little damage is at first noticeable, but from the end of August on through the winter the maggots burrow into the sides of the leaf and then gradually form tunnels which grow into blisters, often covering the whole leaf.

The larvæ reach maturity in April and May, and are then 3 mm. in length, white in colour, showing a green intestinal tract in many specimens due to the chlorophyll shining through the integument. It then enters the pupal stage, which is passed in the leaf, in a brown oval, flattened puparium, with distinct transverse striæ.

The length of pupal life seems very varied; some hatch out in two weeks, others I have kept for six weeks. Many dead puparia, dark and shrivelled, may be found on the leaves at times, apparently killed by some parasite. The fly emerges from the leaf through a hole previously cut by the maggot.

Gillanders (Forest Entomology, p. 360) speaks of damage always being done to the leading shoots, this is by no means always the case, for I find the larvæ in the leaves all over the bushes, both in standards and clipped holly hedges.

I have found spraying with White's Abol, MacDougall's Summer Wash, and Nico.-Soap beneficial, if done at or soon after the time the flies are seen about.

This of course is only practicable in nursery stock. In nurseries it is advisable to preclude any hollies in the

surrounding hedges, as they form a frequent source of supply of insects for attacking the young plants.

The Increase of the Beech Woolly Aphis (*Phyllaphis fagi* Linnæus).

Many enquiries were received concerning the Beech Aphis (*Phyllaphis fagi* Linn.), in 1913. It seems to have increased at an enormous rate that year and quite spoilt many beech hedges and copper beech. Fortunately Mr. Ernest Green, of Bearsted, Kent, sent me a number in the autumn, which included males and oviparous females, and ova, and errors can be corrected regarding the sexuparæ and their eggs.

This Woolly Aphis was reported as killing a fine beech hedge at Godalming by Mr. C. Burgess, of Birch Hanger. In June I paid a visit to Birch Hanger, and found that a vast amount of Aphis had been present, but was being controlled by spraying, and undoubtedly from the appearance of the foliage it had done some serious damage, but I do not think that the dead portions of the hedges was due so much to the Aphis as to the Scale Insects present (*Pseudococcus aceris*).

On June 10th Mr. J. S. Davidson, of Aberdeen, wrote saying his beech hedges were badly affected with Woolly Aphis, and that it was bad in the district and asked for a remedy.

It was also sent by Mr. Ginningham from Bristol, on June 13th, a few being alatæ, and enquiries made by Mr. Blakey from Newark. It was also very abundant round London, and at Hastings and Battle, in Sussex, and Purley, where the beech trees were smothered on July 7th. It was also abundant on the Copper Beech at Little Hadham, Herts, in May.

During the past autumn the sexuparæ sent me from Bearsted oviposited, and I find that the ova were laid exclusively on the leaves, and not as has been previously stated at the base of the buds. As a rule only a single egg was laid on each leaf. Moreover, they have retained their dull yellowish-brown colour. They are covered with a fine fibrous substance or coarse meal, and are fixed tight on to the under surface of the leaves, and fall with them to the ground. The last ova were laid on November 7th.

The structural characters of the different stages of this Aphis are figured here.

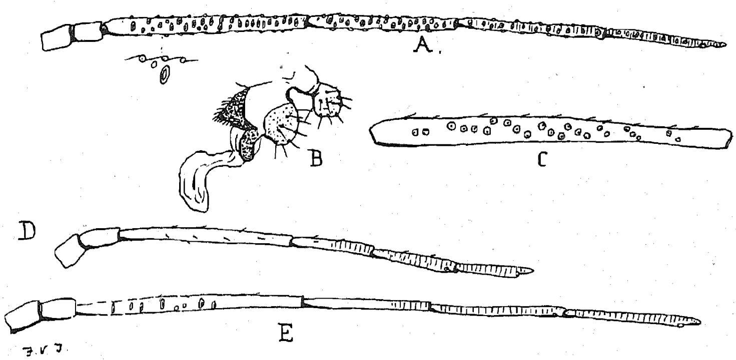


Fig. 62.
Phyllaphis fagi Linn.
A, Antenna of male; B, external sexual organs of male; C, hind tibia of oviparous fmale; D, Antenna of oviparous female; E, Antenna of alate female.

The *oviparous female* is wingless, and varies from yellow to yellowish-orange; the head is brown in the middle, the body with ten median brown bars, often showing a pair of pale round spots on each, and eight pairs of lateral brown spots. The cornicles are only pores, surrounded by a brown area. Legs yellow, apices of the tibiæ and all the tarsi darkened. Antennæ dark brown, yellow at the base. Eyes black. There are no sensoria on the antennæ; the first segment is wider, but shorter than the second, the third is the longest, as long as the fourth and fifth; fourth, fifth and sixth nearly equal, the latter slightly the shortest, all three imbricated. Hind tibia, not very broad, with twenty-two to twenty-five sensoria over its whole length.

The *male* is winged; head dark; thoracic lobes, shiny black, a black spot on the pleuræ; bright orange-yellow between the black thoracic lobes and on the sides. Antennæ long, dark brown, pale just at the base of the third segment. Abdomen vivid green, with six black median transverse bars and slightly darker green lateral spots and ventral cross-bars. Legs dark brown. Stigma greyish-brown. The antennæ

have the first and second segments nearly equal, the third the longest with many sensoria, and also with prominent lateral ones ; the fourth, fifth and sixth about equal in length, the fourth with many sensoria, the fifth with fewer, the sixth with nine to ten before the short, blunt tail.

The third segment of the alate viviparous female has six large elongated oval sensoria and two small ones.

An Aphis Pest of *Abies grandis, etc.*

On the 29th of May, a piece of *Abies* (*Picea*) *grandis* was received from Avondale, Rathdrum, Ireland, covered with a large Aphis and with the note that "it is clustered on the leaders and has apparently caused the stripping of the needles."

The Aphis proved to be our largest species of Lachnus, the *Lachnus piceæ* of Walker.

This large and handsome species often occurs in dense masses on almost all kinds of Abies, or as they are now called Picea, but is least common on *Picea excelsa* and I have not found it on *Picea sitchensis*. It has also been sent me from *Pinus sylvestris*.

The strange thing about this species is that it may occur for a time in enormous numbers on a tree, then it becomes winged and disappears. One would think that the migration of a large and marked species such as this could be easily followed, but I have repeatedly failed to find where it migrates to. It is worthy of note, however, that it has been found on both Picea and Pinus.

One attack observed some years ago at Kennington was on *Picea pectinata*, and on this species the needles were rapidly killed by it. On the other hand it seemed to have no effect on *Pinus sylvestris*, although swarming on it.

The Heather Beetle (*Lochmæa suturalis* Thoms).

This beetle, which I recorded in 1909 as being very harmful to the heather at Caldy, near Hoylake, Cheshire was reported again in July, 1913 by Mr. Arthur Worsley, who stated that much heather was then destroyed and that again this year (1913) he found "a similar browning of the heather and its general withering. In the affected plants are many of the enclosed caterpillars."

These proved to be the larvæ of *Lochmæa suturalis*, and the heather sent with them was speedily destroyed.

A large number were sent me and they fed ravenously off the heather. They commenced to pupate on August 1st, the last going to earth on the 14th. Mr. Worsley, writing again on August 6th, stated that they were also fast disappearing, burying themselves in the ground.

These pupæ hatched out in September and the adults lived until October and then died off. The larvæ (Fig. 63) were pale brownish-green to dull yellowish, with dark head, a dark, pronotal plate, each segment with two dark median transverse bars, the hind one slightly the smaller, with three

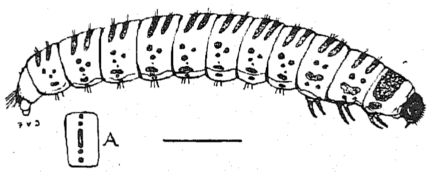


Fig. 63.
LARVA OF THE HEATHER BEETLE (*Lochmaea suturalis*).

lateral dark spots beneath them, two above, one below, except on the thoracic segments, in which there are only two and a large dark spiracular spot beneath. In the abdominal segments there is a dark sub-spiracular spot beneath the three and one more ventral to this, the spiracles are small and black; pre-anal plate black, and there are also black ventral spots. Legs black. From the dark tubercular spots arise short hairs. The ventral spots are one long median and two round lateral ones. Length one-third of an inch.

OTHER FOREST TREE PESTS.

1. Goat Moth Larva in Soil.

A fully matured larva of the Goat Moth (*Cossus ligniperda*) was received on the 14th of February from Heane Barn, Saltwood, Kent, which was turned up whilst ploughing a piece of ground that had wurzel last year followed by Lucerne.

2. Galls on Alders.

From Milltown, Co. Kerry, Ireland, specimens of galls on alders were received. They were full of Cecidomyia larvæ, which were later identified as those of *Cecidomyia salicis*. (*Vide* p. 318.)

3. Aphides attacking Conifers.

A special report has been drawn up and published in the Official Organ of the Association of Economic Biologists* on the Green Spruce Aphis (*Aphis abietina* Walker), which has done such damage to the Sitka and Norway Spruce in Ireland and the South of England during the last year.

Communications have been received from a large number of localities and have been incorporated in the Report. From Woking the following have been received or were found during a visit there in June, causing harm to conifers in nurseries :—*Eulachnus agilis* Kalt., in Scots and Austrian Pines ; *Lachnus pini* Linn ; *Lachnus pinicolus* Linn and *Lachnus fasciatus* Burm.

Scotch Pines were also attacked by *Schizoneura fuliginosa* Buck and by *Pineus pini*. *Lachnus pini* was also sent from Holmes Chapel, Cheshire, and from Windermere, I received specimens of *Lachnus fasciatus* Burm. from Mr. Rymer Roberts, with the following note : "I am sending this Aphis because of the damage done by it in 1911 here to the Spruce. They were then in large numbers between the needles on the year's growth and presumably through the loss of sap caused the leaves to drop."

4. The Ash Scale (*Chionaspis salicis* Linn.).

Young Ash trees so badly attacked by the Coccid (*Chionaspis salicis* Linn.), that they were being killed by it were received from Captain L. Creaghe Creaghe-Haward, of Milltown, Co. Kerry, Ireland, on May 7th. Judging from the specimens sent the attack must have

* The Annals of Applied Biology, Vol. I., No. 1., pp. 22—36. Figs. 10. (1914).

been very severe, as the bark was actually covered with the insects.

This Coccid attack is frequently overlooked, but there is no doubt, as I have previously shown, that it does much damage to ash saplings and to willows. It is also found on osier, alder, lilac and dogwood.

5. **The Felted Beech Coccus** (*Cryptococcus fagi* Barens.). This disease has made its appearance at Hextable, near Swanley, from whence specimens were sent by Mr. H. Barnett in August. Another bad attack was recorded by Mrs. H. Rothwell from Kells, Ireland, who wrote that the disease was spreading very rapidly there and that it had already practically killed one fine beech.

There is no reason for allowing this Coccid to kill trees if one wishes to save them, for it can easily be destroyed by spraying with caustic soda, 2 lbs. to ten gallons of water, and 4 ozs. of soap, or with the Woburn Winter Wash, but two applications are usually necessary.

INSECTS, ETC., CAUSING ANNOYANCE TO MAN'S DOMESTICATED ANIMALS.

The Poultry Bug (*Cimex columbaria* Jenyns.).

On the Continent it is said that poultry and pigeons are not infrequently attacked by a bug, the *Acanthia* or *Cimex columbaria* of Jenyns. Previous to 1913 I had only once seen this insect in Britain,* and then in very small numbers amongst pigeons at Kingston-on-Thames, birds which were certainly kept in a clean condition, but in an old granary that was very difficult to deal with as far as our modern ideas of cleanliness go.

Railliet records (Bull. de. la Soc. de med. Vétér, pratique, p. 99, 1890), that hens when nesting are so tormented by these insects that they finally abandon their eggs, on which are then seen small specks of the bug's excrement.

During the past year two consignments of these loathsome looking insects, very similar to the two Bed or Human Bugs (*Cimex lectucarius* and *C. rotundatus*), reached me from Yorkshire, one in June, the other in February, from Hull.

With the last consignment I found the insect in all stages, from quite freshly hatched young, to pregnant females, the tin containing great numbers of them, with feathers amongst which they had been collected. This insect (Fig. 64) which when mature reaches one-fifth to one-quarter of an inch in length, like the other members of its genus is provided with a sharp piercing rostrum by means of which it takes the blood of the fowl or pigeon during the night, but in dark roosts at all times on nesting birds or laying birds.

They evidently feed often, for those I received had only been two days in transit, and were all flat bug-like creatures

* "The Parasitic Diseases of Poultry," pp. 36, 37, fig. 112. 1896. F. V. Theobald.

A number were put on one of my fowls, and at once commenced to feed; next morning they were found in the box with their abdomens much expanded, almost Tick-like in appearance. These were removed, and in a few hours they showed a marked decrease in size, and in three days all had the usual flat Bug-like appearance. These were then replaced, and at once fed again. Some hours after repletion they void a

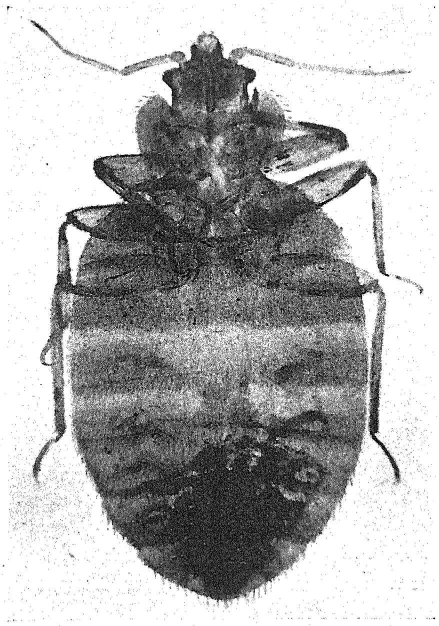


Fig. 64.
ADULT POULTRY BUG (*Cimex columbaria* Jenyns) × 15.

considerable amount of dark reddish-brown fluid, which is probably the excrement found on the eggs by Railliet.

This bug was so active and so easily got over water that I soon killed them off instead of following their life-cycle; particularly as I found they not only bit birds, but were by no means averse to man.

The general colour is bright-brown, some dark brown, others pale yellowish-brown. The young are almost white

and gradually darken in colour in the later instars. The young clung tenaciously to the feathers in which they were sent and were not nearly so active as the adults, nor did they seem so ravenous after food.

The male has marked terminal claspers. These bugs seem very difficult to eradicate. All one can do is to

Fig. 65.
YOUNG POULTRY BUG.

thoroughly clean out the houses and burn all the refuse, and then well soak with a strong paraffin emulsion, so that it runs into all crevices, and then give a good coat of lime-wash and carbolic.

Should the bugs still persist, then a thorough fumigation with brimstone candles should be tried, using the maximum number of candles and seeing that the house is first air-tight.

ANIMALS CAUSING ANNOYANCE TO MAN.

Flies causing annoyance indoors.

Lady Colvin, of Langley, Liss, Hampshire, wrote complaining of the swarms of flies that invaded her house in the autumn. They were described as coming in by hundreds in September and October, and in 1913 they were worse than ever. They were noticed as not flying about the house, but settled in the windows, on the curtains and hangings.

A large boxful was sent and they proved to be two species, *Pollenia rudis* Fabr. and *Pyrellia lasiopthalma* Macq. The latter was identified by Mr. Collins as there is another closely related species, *P. eriopthalma*, Macq. of very similar appearance.

Pollenia rudis is a very common house-fly, which is often found on the windows in autumn and spring, before the common House Fly (*Musca domestica*) makes its effects felt. It hibernates in the adult stage in houses, lofts, stables and out-buildings. It is a shiny brownish-black colour, the thorax with golden hairs and black chaetæ. The abdomen is ornamented with ashy-grey and brownish-black patches with zig-zag outlines, the shades varying with the light—the pale colour is due to the tomentum, while the dark is the colour of the true integument. It occurs in America where it is called the "Cluster Fly," Butler (Household Insects, p. 210), quotes Professor Riley as follows regarding a visitation at Geneva, New York: "They were at once a terror to all neat housekeepers, and from their peculiar habits a constant surprise. People soon learned to look for them everywhere—in beds, in pillow-slips, under table covers, behind pictures, in wardrobes, nestled in bonnets and hats, under the edge of carpets, etc. A window casing solidly nailed on the wall, when removed, showed a solid line of them from top to bottom.

"They like new houses, but are also found swarming in old, unused buildings. But most of all they like a clean dark chamber, seldom used, and, if not disturbed, form in large clusters about the ceilings. Under buildings, between earth and floor, they are often found in incredible numbers."

Nothing seems to be known of the early stages of this common fly or where it lives and breeds.

Pyrellia lasiopthalmia is metallic blue, it does not seem to have been recorded as a house-fly pest before, but in this case it was as common as the *Pollenia*. Nothing is known of its life-history either.

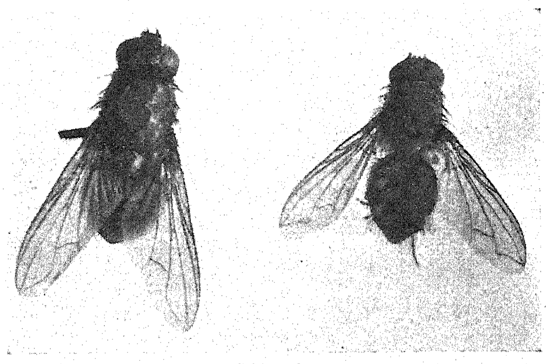


Fig. 66.
Pyrellia lasiopthalma Macq., and *Pollenia rudis* Fabr.

Another fly recently found invading houses in great numbers is *Chloropisca circumdata* Meigen, the *C. ornata* of Loew.

The Rev. E. N. Bloomfield had them sent from Totnes in South Devon, where they were swarming in a room in thousands. These pretty little yellow and black flies were also sent from Bearsted, where Mr. Green tells me they had been appearing in immense swarms for several weeks in the house of a neighbour, frequenting two or three upper rooms, the ceilings of which were blacked by the swarms of flies.

The same species swarmed in my own house in the autumn of 1912 and 1913, and I found that they were attracted in by the warmth from the close ivy outside, where they were collected in myriads.

I found it most difficult to destroy them. *Pyrethrum* and tobacco fumes were used, but great numbers survived. Sulphur could not be used owing to the brass and gilt-framed pictures and glasses, etc., and eventually they had to be swept off the ceilings into cloths and burnt. They made no spotting on the ceiling, but were a constant disfigurement. In habits they were more or less sedentary, crawling about slowly and never seeming to care to fly unless disturbed, and then in short jerky movements, so that it was impossible to catch them with a net. In the winter I found them in swarms sheltering deep in the ivy outside.

ANIMALS INJURIOUS TO MAN'S STORES, FURNITURE AND BUILDINGS.

The Mediterranean Flour Moth (*Ephestia kühniella* Zeller).

This moth, which was sent from Widdington, near Newport, Essex, in September, 1912, with a note that it was occurring in some sacks of whole-meal flour, with enquiries as to its nature, was also received from a bakery in Yorkshire, and again from a bakery in Wye in 1913, and from two mills in the West.

Some moths were kept, and the following results of their breeding in the College Laboratory are given here. The Mediterranean Flour Moth is usually looked upon as a mill pest, but besides that it is often a great nuisance in bakeries, as mentioned in the opening sentence, may become so in private houses, as mentioned in my last report.

This insect seems to have been unnoticed until 1877, when the moth was discovered in a flour mill in Germany, and Zeller described it and gave an account of its life-cycle in 1879. Then it invaded Belgium and Holland, and in 1886 it appeared in England, and now seems to be very widely distributed all over Britain. In 1889 it made its appearance in great numbers in Canada. In 1892 it was reported as injurious in Californian mills, and in 1895 it occurred in New York and in Pennsylvania.

There is, however, strong evidence that it was known in Europe as early as 1840, Danysz stating that it was known to millers in France at that time, and Johnson believes it occurred at Kiel in 1858; and it is certain that the outbreak in 1872 at Constantinople was due to this species. It is now widely spread over North America and Canada, and occurs in South America, in Chile, Mexico and the Argentine. In

this country it at first increased rather slowly, but year by year it has gradually spread and we may find it over most of the Islands. The same happened in America, where its progress was at first very slow, but by degrees it spread until it is a recognized pest in very many States, and is known in all the milling centres from the Atlantic to the Pacific coasts, and from Canada to Mexico.

At one time it was thought to be of American origin, for its presence in America can be traced back to 1880, and Johnson states that it is found in California in the nests of Humble Bees, pointing to its native origin. On the other hand there is much evidence to show that it is European, and probably originated in the Mediterranean region, the first outbreak in Britain being traced to flour imported from Trieste and Fiume to London.

It also occurs in Australia, and I have received it from the Cape.

The damage done in mills is often very great, the caterpillars make irregular cylindrical tubes of silk and meal or flour and dust in which they feed, and also later spin much irregular silk amongst the flour, forming a felted mass, which clogs up the machinery, frequently causing the stoppage of the mills. We thus not only get great loss by the damage done directly to the flour, but also loss by the stopping of the outine of the mills.

In bakeries and houses it may do much damage by spoiling the flour, matting it together, and causing great inconvenience. It will feed also on wheat, bran, and almost all raw or prepared cereal foods.

It lives also in the nests of some of the common wild Bumble Bees (*Bombus* sp.), and in the nests of the Hive Bee. I have found that it will readily breed in combs of the Hive Bee. Its distribution in Britain at first kept to London and other large towns, but since 1904 it seems to have gone further and further afield, and to be found now in many villages in England, Wales and Scotland, and Carpenter as long ago as 1903, reported it as being established in the North of Ireland.

The Moth belongs to the Phycitids, and is easily recognized. The wings are long and narrow, pale leaden-grey,

the front pair with zig-zag dark bars, the posterior pair having a pale area on the one side; the wider hind wings are dull whitish-grey with a darker border, and the thorax and abdomen are grey, the latter somewhat paler than the former. The wing expanse is less than an inch. When resting the wings are folded in a cylindrical manner over the body, the tip of the abdomen pointing outwards between the wings.

The moth lays from 50 to 200 ova, usually singly or in lines of eight to ten. The eggs take five to ten days to hatch. In one case fourteen days.

The larva is dirty whitish-grey, now and then with a faint creamy tinge, at others almost white or dull pink, with small dirty dot-like tubercles from which proceed fine pale hairs; a reddish-brown head and thoracic shield and the usual legs. When full grown it reaches about half an inch long. It then forms a cocoon amongst the flour or meal and changes into a pale reddish-brown to chestnut-brown pupa.

It has been generally stated that in Europe that this moth completes its life-cycle in two months. It is probable that with out-door conditions not more than three broods would occur in the year.

In America it has been found that under most favourable conditions it may pass its life-cycle in thirty-eight days, and that in well-heated buildings and mills as many as six generations may occur in the year

Specimens I obtained from Wye in January, 1913, were placed in a mouse-jar with flour, with the hope of breeding out the parasites referred to in my previous reports (Rept. year ending Sept. 30th, 1911, p. 14, and Rept. year ending Sept. 30th, 1912, p. 103). This parasite, *Nemeritus canescens* Grav. I was not only unable to breed any more of, but specimens taken in a Wye bakery put in with many larvæ, evidently did not oviposit as none have appeared since.

This colony, started in January, 1913, is still living

From January, when about twenty nearly full-fed larvæ were put into the flour, till January 14th, 1914, no less than five broods of moths have appeared, and since then, up to May 30th, 1914, three more. It thus appears that kept in a fairly warm room that we may have five broods at least in the year. They hatched somewhat erratically, the dates of the

broods being as follows :—First brood, February 2nd ; second, April 7th ; third, July 3rd ; fourth, November 7th ; the fifth, January 12th. Since then a brood occurred on March 16th (1914), and another in May.

The moths soon pair and lay their eggs over a period ranging from six days to two weeks.

I may point out that no fresh flour has been put in the jar since June, and that the colony is evidently dying out from the return shown here :—

February 2nd to 10th—16 moths.
March 29th to April 7th—47 moths.
June 30th to July 3rd—52 moths.
November 7th to 14th—27 moths.
January 12th to 14th—12 moths.
March 16th to 17th—3 moths.
May 14th to 29th—3 moths.

Whether this decrease is due to degeneration or want of fresh food material I do not know. One thing is certain that the larvæ can subsist on very little food. It is surprising the small amount of flour which has been given them, and the completely matted substance that is left.

Some of the larvæ pupated amongst the flour, but the majority in the crevices of the muslin on the top of the jar.

Bakeries and private houses may be cleared of this pest by ordinary cleaning, but when it once gets a firm hold of a mill more drastic measures must follow, frequently necessitating the closing down of the mill. To eradicate the pest under such circumstances, two methods are in vogue, one fumigation with hydrocyanic acid gas, the other, which appears far more successful, the application of steam with force to all corners and crevices where the insects collect, after the place has been well cleansed down.

The Tabby or Grease Moth (*Aglossa pinguinalis* Linn).

Larvæ of this moth were sent me from Norwich on April 11th, by Mr. W. H. Burrell, with a note stating that they were taken in numbers from sacks of barley, which they were destroying, by an Oxfordshire farmer. The larvæ were kept and hatched out on June 5th, into the Common Tabby or Grease Moth (*Aglossa pinguinalis*).

This moth (Fig. 67) is very common and widely distributed over Britain. It is about an inch in wing expanse, front wings are brownish grey to brown with darker zig-zag lines across them, the hind wings are uniform in colour, the veins slightly darkened; thorax and abdomen greyish-brown. It may be found in June, July and August in houses, stables, lofts and sheds, and appears to love dark places.

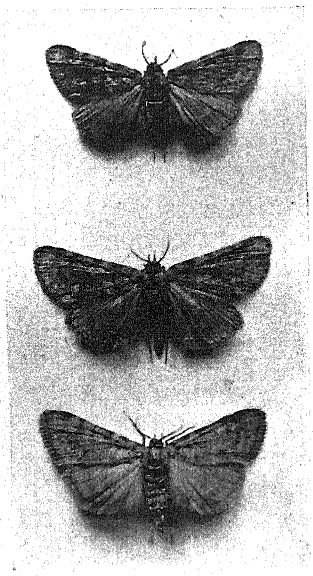


Fig. 67.
THE TABBY OR GREASE MOTH
(*Aglossa pinguinalis*).

The moth lays her eggs in vegetal refuse, amongst chaff, corn husks, and general dry rubbish

The larvæ are at first small, pale, flesh-coloured caterpillars, but as they grow they darken in colour and eventually become shiny blackish-brown, rather flattened and with dark shiny head and darker bands on the body, and the normal number of legs. They live in tubes of silk and rubbish spun up amongst the *débris* or grain that they live in, and live almost in total darkness, not leaving the galleries they produce until nearly full fed.

These tubes of silk and refuse are lined within with a smooth grey silk. Here they live from July or August right through the winter until April. In that month or in May they leave their tunnels and wander about, looking for a place in which to pupate.

Pupation takes place in a loose silken cocoon mixed with rubbish, but in the case of those sent me it was formed amongst the barley cobs which adhered to the case

The pupa is provided at its tail end with some recurved hooks by means of which it holds on to the cocoon.

A Storeroom Pest (*Carpoglyphus anonymus* Haller).

This well-known store pest was received from Mr. W. Welch, of Cranleigh, Surrey, on June 11th, with a note that "They are all over our storeroom, but are especially found in the sugar and more especially around a jar in which West Indian sugar is kept."

This mite, the *Carpoglyphus anonymus* of Haller, may be found in dried fruits, damaged flour, glucose of commerce, in decaying potatoes, in Dutch, Cheddar, and Sept-Moncel cheeses, and in Senna. In South Europe it occurs in sweet wines, and often increases in the bottles to such an extent that many of the great Paris wine merchants have to adopt special treatment.

It frequently occurs in very large colonies and may do much damage. It is practically transparent, but may be dull white, creamy, pale pinkish or dull grey, with pink legs. Michael (Mono. Brit. Tyroglyphidæ, II., p. 46), says that the varied colours are due not only to the colour in the alimentary tract, but that the light passing through the coloured contents is refracted and reflected in the semi-transparent creature all over the body, and moreover, the liquid contents of the canal soak through and flood and stain the other organs; thus its colour depends upon what it has been feeding. Michael records that specimens taken on confection of senna in a druggists' shop, when transferred to prunes, and the young reared on that fruit gradually lost their yellow colour and finally assumed an ashy grey, due to the colour of the dried prunes.

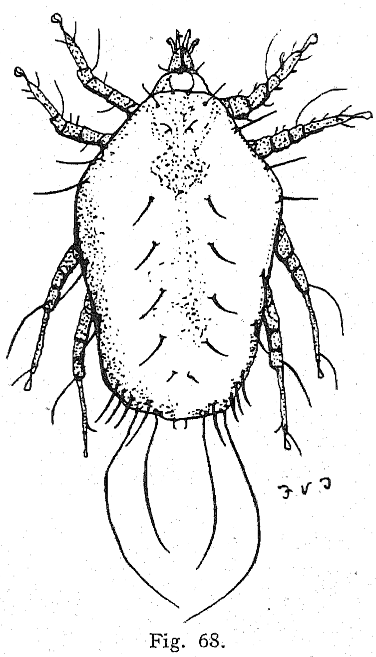


Fig. 68.
Carpoglyphus anonymus Haller
(greatly enlarged).

This species is ovo-viviparous, and they appear to leave their food before ovipositing according to Dr Nalepa, and select some suitable place, such as the stems of the fruit, leaves, wood shavings, etc, for the purpose; if in confinement, it lays its eggs on the walls of the breeding cage. "The eggs," says Michael, "are often fixed by very short stalks arising from below the oral pole of the egg."

This acarid is found in France, Germany, Holland, and Italy, as well as in Britain. Probably it is world-wide in distribution. Its food is evidently very varied, for beyond the things mentioned, Michael records that he found it devouring the thin film of dried gold size, which fastened the glass ring which formed the side of the cell to the glass slide which formed the bottom, in which he kept the specimens.

A Mite (*Aleurobius farinæ* Koch) causing annoyance in a Dairy.

On May the 7th I received a communication from Captain Myers, of Jacques Court, Elham, that he was having "great trouble over the enclosed insects in my dairy. Contents of dairy, which is always kept scrupulously clean, is about 4,500 cubic feet. I have fumigated with five sulphur candles, each candle sufficient to do 1,200 cubic feet. Result nil. The extraordinary thing is they seem to congregate most on a stone slab. This slab is near a window. Can they come from outside. They are causing me intense inconvenience and expense. I have fumigated twice."

A few specimens were sent, and they proved to be *Aleurobius farinæ* of Koch. This mite attacks corn, flour, and meal of all kinds.

As this was apparently a very interesting case I visited Jacques Court at Captain Myers' request.

The mites were found on the stone slab under the window referred to. This window had been pasted up with brown paper, but there were evident crevices through which these minute mites could make their way. Some were also found along the edge of one wall and floor. An examination was then made of the upper storey, where feeding stuffs were kept and in some of these thousands of the acari could be found,

in fact some meal was literally swarming with them. This storey was boarded in with wood, and it was quite evident many of the acari escaped from the meal down the wall of the converted oast-house, and entered the dairy below, via the small window, falling on the stone slab below; others had entered from below through crevices in the partition.

The remedy was obvious, namely the rapid feeding off or removal of the infested feeding stuffs above, and then thorough fumigation. In June Captain Myers wrote that he had delayed writing until he was quite sure he had got rid of the plague. He wrote as follows:—"I removed the corn, meal, etc., out of the end bins upstairs and washed with paraffin. I paraffined the dairy, both rooms, tarred the joint of floor and wall outside of partition. Then I fumigated with ten sulphur candles, and this did for them. They have not appeared since."

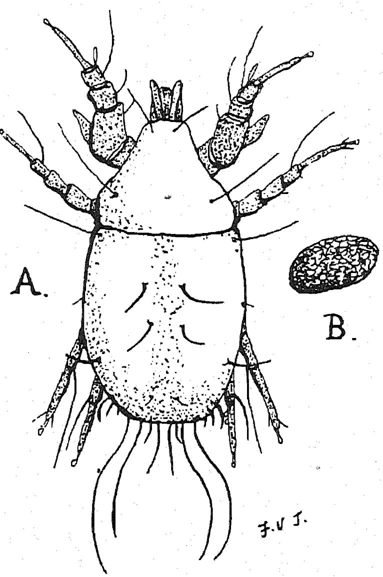


Fig. 69.
Aleurobius farinæ Koch (greatly enlarged).

This is a very abundant mite, common in stored corn of all kinds, and in all manner of flours and meals, and it is also found in cheese. It also lives on prunes, dried hops, and many other dry vegetal substances. Michael also records it on decaying stored mangolds, and on tobacco and maize, and found it in large numbers on the external membrane of sausages. It is common all over Europe, and Michael records it in large quantities in wheat imported from America, and was informed that it was only during the last few years that American wheat had been infested, although New Zealand wheat had been so affected for a long time.

The damage done to grain is often serious, and also to flour. The corn and feeding meals at Captain Myers' was much damaged by them in places. It usually, as Michae says, attacks the corn cob at or near the end, it eats a small hole in the epidermis with its jaws, and gradually eats its way into the kernel, and in the end a dry husk remains, with a minute hole showing on the shell. In these attacked grains we find the mites in all stages of existence.

The colour varies, but it is usually semi-transparent white, the legs and rostrum reddish-brown, some show a dull mauve or pale bluish tint; the skin is shiny and there are some long lateral and posterior hairs as shown in the figure (Fig. 69). In the male the front legs are very marked, a character which enables us to at once identify this acarid. The female is 0.5 to 0.7 mm. long, the male 0.4 mm. The eggs are laid in or amongst the feeding stuff, and are oval, white and granular, about 0.1 mm. long. They can evidently breed with great rapidity and if left alone will soon reduce a heap of corn to husks or meal to a foul powder.

Damage caused by *Glyciphagus domesticus* De Geer.)

Damage done to furniture was enquired about at the end of September, due to the well-known mite *Glyciphagus domesticus*. It was alleged that the mite came from Algerian fibre. The general idea of upholsterers is that the mite comes in straw, and thus may get into straw palliasses.

As a matter of fact this mite will live in wool, fibre of all kinds, in hay and straw, in many kinds of dried vegetal and animal products, such as dried fruits, horse hair, cork and tobacco.

It often swarms on hay, not only in lofts and stables, but out of doors. It is frequent in rush furniture. Michael records it, quoting Oudemans, in furniture at Assen, the Hague, and at Utrecht, and says that they literally covered the furniture of the whole house, and that they fed on the animal fat which adhered to the not thoroughly cleansed horse hair, with which the furniture was stuffed.

This small mite is 0.4 to 0.5 mm. long, in the female, 0.3 to 0.5 mm. in the male; it is pearly white to dull grey or creamy-

white, and somewhat transparent, the skin smooth, but dull leathery looking, covered with fine markings, with numerous long hairs, feathered on each side, and pinkish legs. It occurs all over Europe, and has even been recorded from Northbrook Island, Franz Joseph Archipelago, by Mr. Fisher, botanist to the Jackson-Harmsworth Polar Expedition.

Wood Beetles in Westminster Hall.

In August the Architect in charge of Ancient Monuments wrote concerning the question of the worm-eaten timbers in the world-renowned Hammer-beam roof of Westminster Hall, which is so seriously damaged that the Hall has to be closed. The beetle causing the harm is the common *Xestobium tessellatum*, which is the frequent cause of damage in old churches and ancient buildings, and also, it appears, a form of "Dry Rot" occurs at the same time.

EXTRA BRITISH ENQUIRIES.

1.—**The Potato Moth** (*Phthorimæa solanella* Boisd.).

An enquiry was received from Mr. F. Stoward, of Leedesville, Western Australia, concerning the Potato Moth (*Phthorimæa solanella*) in July. The caterpillars were stated to be a troublesome pest wherever the potato is grown in the different States of the Australian Commonwealth, and that it attacks both the growing plants and the stored tubers. Information was wanted as to methods of dealing with it in Britain. At present it is not known to occur in this country.

2.—**Chermes attacking Piceas in Italy.**

Specimens of *Picea pectinata* were received from Fratte di Salano, in Italy. They were smothered with *Chermes piceæ*.

3.—Fumigation for Calandra in maize in Southern Nigeria from the Imperial Institute, January 21st, 1913.

4.—Information was sought by Mr. Hammond concerning the Green Bug (*Lecanaum viridis*) in India, attacking coffee.

5.—From Palmerston North an enquiry was received in October for a wash to kill Red Spider and Thrips, both of which were doing much injury there.

6.—**The Rose Cecid** (*Neocerata rhodophaga* Coq.).

From Newark, New York, U.S.A., information concerning the Rose Cecid (*Neocerata rhodophaga* Coquillett) was sought in July. Some extensive rose-growers there were badly troubled by a midge maggot infesting the terminal heads of the roses, which proved to be this species.

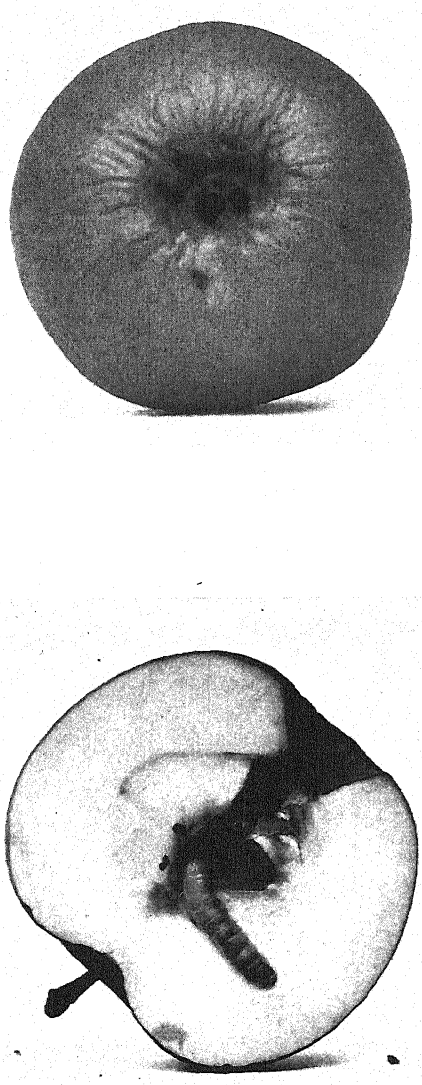
7.—**The Fowl Tick** (*Argus persicus* Fischer.).

Information concerning this Poultry pest was sought from the West of Scotland Agricultural College, Holmes Farm, Kilmarnock. In tropical and sub-tropical countries it is a veritable scourge amongst poultry. The life history and distribution was forwarded.

PLATE I.

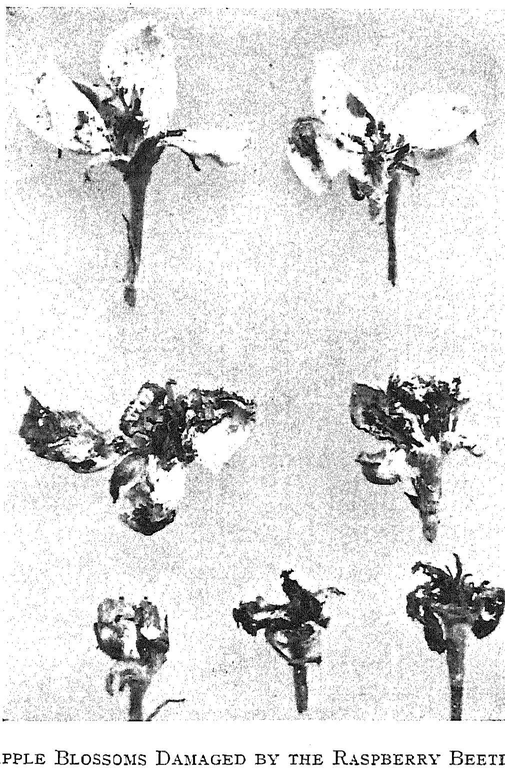
WOOD LEOPARD MOTH
and Damaged Pear Shoot (Half natural size).

PLATE II.



APPLES DAMAGED BY THE LARVÆ OF *Caradrina quadripunctata*.

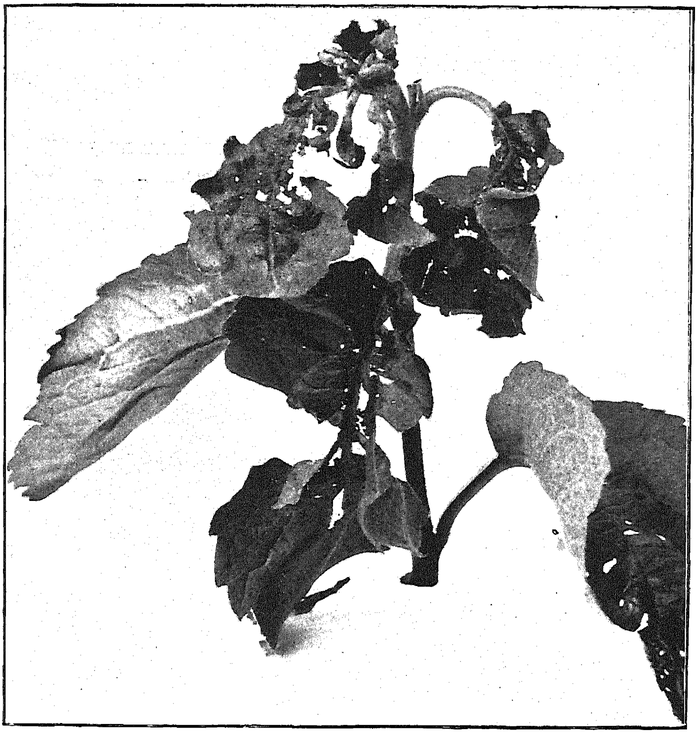
PLATE III.



APPLE BLOSSOMS DAMAGED BY THE RASPBERRY BEETLE
(*Byturus tomentosus*).

Similar damage is caused by Blossom Beetles (*Meligethes*)
and Leaf Weevils (*Phyllobius oblongus*).

PLATE IV.



[F. Edenden.

DAMAGE DONE TO APPLE SHOOT BY GREEN BUGS AND YELLOW SPRINGTAILS.

PLATE V.

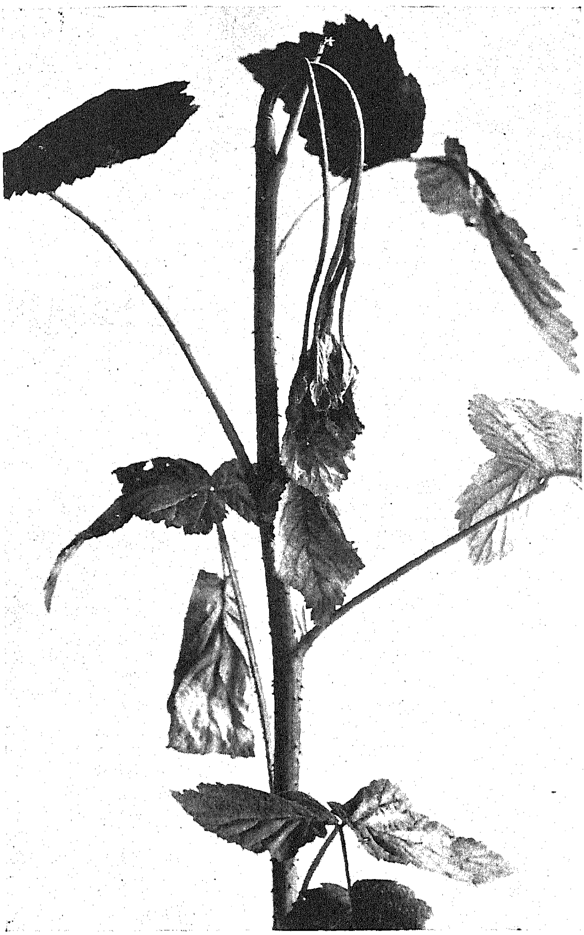
[*F. Edenden.*

CURRANT SHOOT DAMAGED BY GREEN BUGS (*Orthotylus marginalis*).

PLATE VI.

RED CURRANT GALLED BY *Eriophyes ribis* Nalepa.

PLATE VII.



RASPBERRY SHOOT ATTACKED BY A *Phorbia* sp. ?

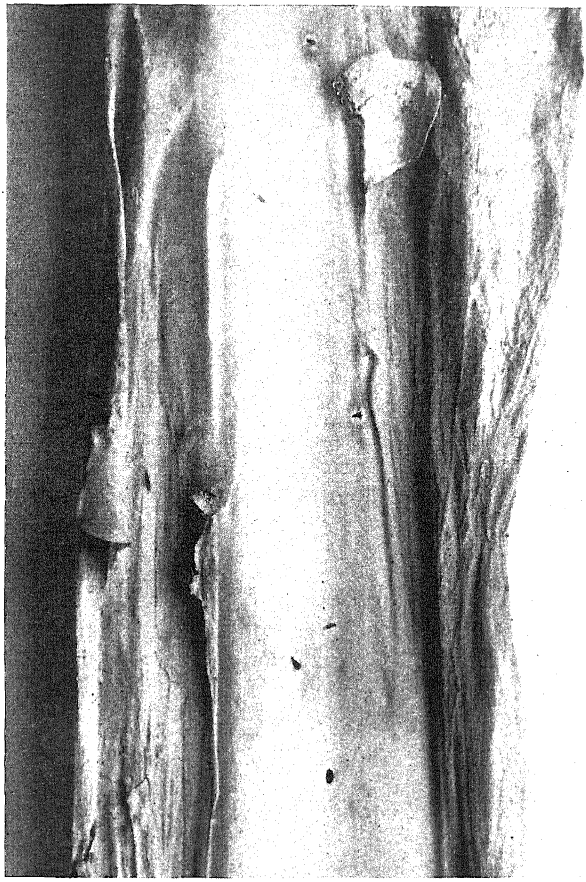
Plate VIII.

Young Cabbage Plants Damaged by the Cabbage Stem Flea Beetle (*Psylliodes chrysocephala* Linn.).

PLATE IX

DAMAGE CAUSED BY THE LARVÆ OF *Phytomyza flavicornis*, SHOWING TUNNELLING INTO THE LEAF STALKS.

PLATE X.



LEAF PETIOLE SHOWING HOLES FROM WHICH THE LARVÆ OF *Phytomyza flavicornis* ESCAPE.

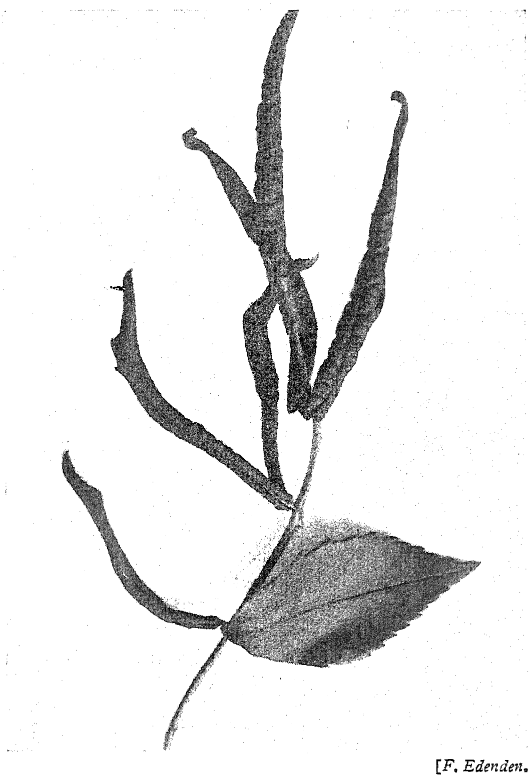
PLATE XI.

LARKSPUR DAMAGED BY EELWORMS.
(Half natural size.)

PLATE XII.

LARKSPUR DAMAGED BY EELWORMS.
Showing stunted Flower Spike.
(Half natural size.)

PLATE XIII.



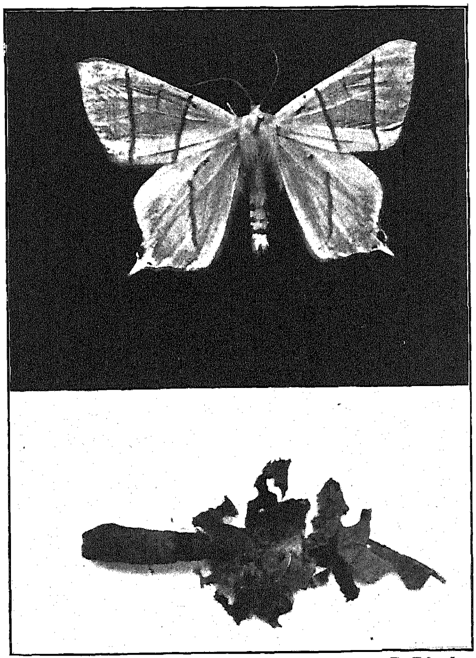
[F. Edenden.

ROSE LEAVES CURLED BY *Blennocampa pusilla* Klug.

PLATE XIV.

RHODODENDRON LEAVES DAMAGED BY *Stephanitis rhododendri*.

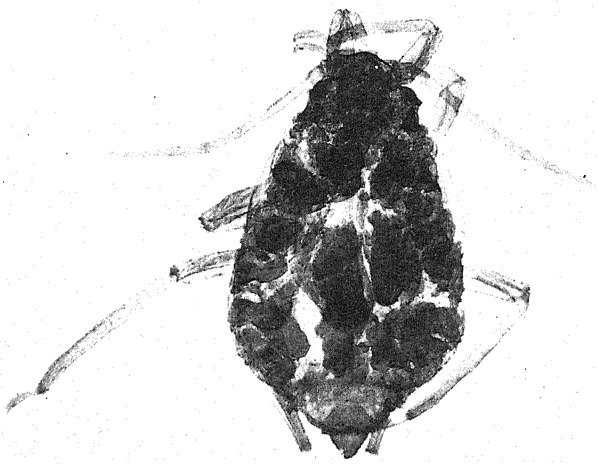
PLATE XV.



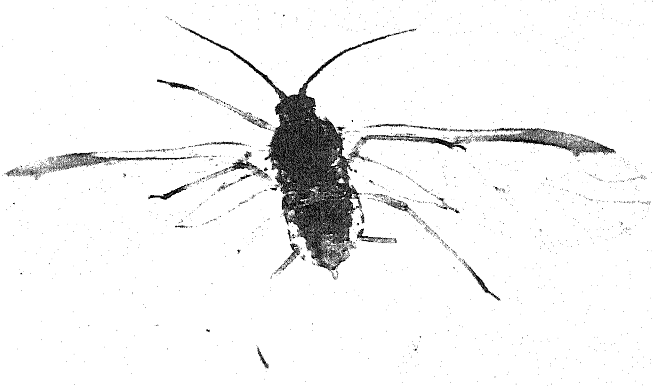
[F. Edenden.

THE SWALLOW TAIL MOTH (*Uropteryx sambucaria*) AND PUPA AND COCOON.

PLATE XVI.



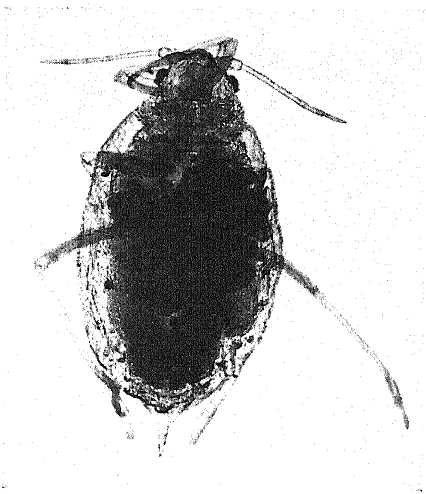
A.



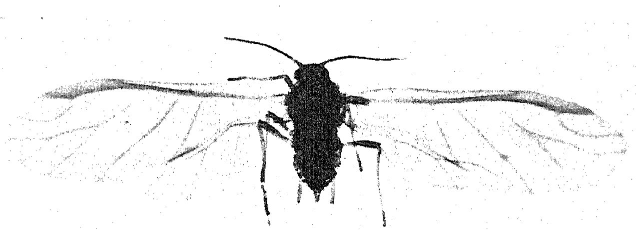
B.

APTEROUS A, AND ALATE FEMALE B, OF *Aphis saliceti* Kaltenbach.
A magnified twenty-seven times. B twelve times.

PLATE XVII.



A.



B.

APTEROUS A, AND ALATE FEMALE B, of *Siphocoryne capreæ* Fabricius.
A magnified twenty-five times. B magnified fourteen times.

REPORT FROM THE
CHEMICAL DEPARTMENT,

FOR THE YEAR ENDING MARCH 31ST, 1914.

THE EFFECT OF FERROUS SULPHATE ON THE YIELD OF POTATOES.

II.

As a result of the experiments carried out both in garden and field during the year 1912, it was found in each case that the application of ferrous sulphate as a top dressing at the rate of ½ cwt. per acre led to no measurable increase in the yield, and no appreciable change for better or worse in the quality of the tubers obtained (*see Journal* of the S.E.A. College, No. 21, for first report on this subject). This negative result, and the consequent lack of agreement with the work of Boullanger, Griffiths and others, who have in many cases found ferrous sulphate to give a marked increase in the yield of potatoes as well as of other crops, was ascribed to the unusually large percentage of calcium carbonate (lime), in the two soils experimented with (10.44 per cent. in the garden soil, 44.6 per cent. in the field soil), especially as it has been observed by at least one previous worker that the effect of ferrous sulphate can be nullified if its application be followed by treatment of the soil with lime or chalk.

For a continuance of the experiments in the year 1913, it was decided to work upon a soil containing a much smaller percentage of calcium carbonate, and the writer must here mention his indebtedness to Mr. G. H. Dean, of Sittingbourne, who was kind enough to place at the writer's disposal the choice of a variety of different soils upon which to continue the experiments.

The soil of the field which was chosen gave the following figures on analysis, and it will be noticed that the percentage of lime as carbonate was about one sixth of that present in the soil upon which Griffiths obtained his results, consequently if this constituent is a determining factor, the

Sittingbourne soil should be considered as one likely to respond to treatment with ferrous sulphate.

SOIL ANALYSES.

	Sittingbourne.	Griffiths.
Moisture	1.92	2.71
Loss on ignition ..	4.34	4.91
Nitrogen	0.21	—
Lime as carbonate ..	0.52	3.25
Ferric oxide	2.83	2.13

Treatment of land and agricultural details.

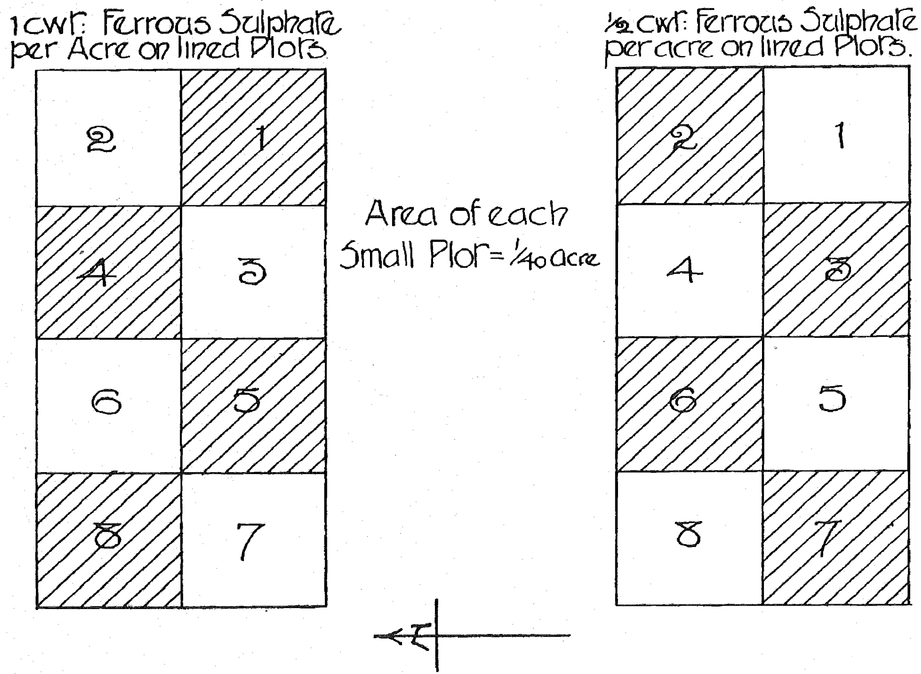
The field experimented upon had received thirty-five loads of dung in the previous October (1912), and was then ploughed. In February, 1913, it was cross ploughed and subsoiled behind the plough, the seed (*variety* Dalhousie) being planted in the middle of April, with no artificial fertilizers.

Experimental details.

It was decided to work with experimental plots of the same size as in the previous year, namely, $\frac{1}{40}$ acre square, eight such plots being measured out for each set of experiments alternate plots in each direction being treated with ferrous sulphate. In addition to such a set of plots in which ferrous sulphate at the rate of $\frac{1}{2}$ cwt. per acre was applied, a second set of experimental plots was similarly measured out in another portion of the same field (it having been shown that there was no difference in composition of the soil), and treated with double the above quantity of ferrous sulphate, viz., 1 cwt. per acre. The disposition and the numbering of the plots were as shown in the figures.

ARRANGEMENTS OF EXPERIMENTAL PLOTS.

The ferrous sulphate was applied to the plots to be treated on May 21st, the larger crystals of the salt being coarsely



ARRANGEMENT OF EXPERIMENTAL PLOTS.
The lined plots were treated with ferrous sulphate.

powdered, and the weighed quantities being broadcasted by hand after mixing with about twice to three times their volume of sand. Fairly heavy rain fell within half-an-hour after the application.

The tubers from the right hand (south) experimental area were dug by hand on October 17th, and weighed. The haulm was also weighed from the two central rows in each plot, and then calculated for the total area of the plot. In the case of the north experimental area, the potatoes were machine-dug and hand-picked and weighed on October 24th.

CROP YIELDS OBTAINED FROM THE SOUTH EXPERIMENTAL AREA, in which the treated plots had received ferrous sulphate at the rate of ½ cwt. per acre.

No. of plot.	Treated or untreated.	Total weight of haulm.	Total weight of tubers.
1	Untreated	122½ lbs.	739 lbs.
2	Treated	155	795½
3	Treated	160	700½
4	Untreated	172½	757½
5	Untreated	150	716½
6	Treated	170	728
7	Treated	157½	635½
8	Untreated	167½	690

Total haulm { from untreated plots = 612½ lbs.
from treated plots = 642½ lbs.

Total tubers { from untreated plots = 2,903 lbs.
from treated plots = 2,859½ lbs.

Average difference in lbs. of tubers per plot = 10¾ lbs.

Probable error of average in lbs. of tubers = ± 23 lbs.

The results show that the ferrous sulphate has no effect in increasing or decreasing the crop, the difference between the average figures obtained for the treated and untreated

plots being well within the calculated probable error, using the formula P.E. (probable error) $.67\sqrt{\frac{\Sigma}{n(n-1)}}$.*

CROP YIELDS OBTAINED FROM THE NORTH EXPERIMENTAL AREA, in which the treated plots received ferrous sulphate at the rate of 1 cwt. per acre.

No. of plot.	Treated or untreated.	Total weight of tubers.
1	Treated	945½
2	Untreated	898
3	Untreated	594
4	Treated	914
5	Treated	658½
6	Untreated	815½
7	Untreated	602½
8	Treated	900½

Total tubers { from untreated plots = 2,910 lbs.
from treated plots = 3,418 lbs.

Average difference in lbs. of tubers per plot $= \frac{508}{4} = 127$ lbs.

Probable error of average $= \pm\ 49$ lbs.

Although the probable error of the average is relatively high in this case it is seen that the average difference between the yields in the treated and untreated plots is 2.6 times (i.e., $\frac{127}{49}$) the probable error, from which it is to be inferred that it is practically certain (to be precise, ten chances to one) that the increased yield is due to the difference in manurial treatment, *e.g.*, treatment with ferrous sulphate.

An increase of 127 lbs. of tubers per plot of $\frac{1}{40}$ acre in extent is equivalent to 40×127 lbs. = 2 tons 6 cwts. per acre.

The cause for the comparatively large variation in the cases of plots 3, 5 and 7, is unknown, but undoubtedly the use of

* See "The Interpretation of Experimental Results," by Wood and Stratton (J. Agric. Sci., Vol. III., p. 417).

a machine for digging does not allow of nearly as great an accuracy as when this operation is carried out by hand. It is noticeable that the yield of tubers on the four untreated plots (2,910 lbs.) is very close to the two yields (2,903 and 2,859 lbs.) obtained in the south experimental area, where the ½ cwt. of ferrous sulphate had no effect.

Similar experiments are being again carried out with larger dressings of ferrous sulphate.

THE ADDITION OF SOFT SOAP TO LEAD ARSENATE FOR SPRAYING PURPOSES.

By D. R. Edwardes-Ker.

In connection with several questions that were addressed to the Entomological Department with regard to the advisability of mixing soft soap with suspensions of arsenate of lead in water for spraying purposes the following investigations from the chemical side of the question were carried out.

Arsenate of lead, acting as a direct poison for caterpillars and other biting mouthed insects, should be applied in as pure a form as possible, suspended in water, and sprayed direct on to the leaves. In most cases, however, there are found to be present small proportions of *soluble* arsenic compounds, and although generally this soluble arsenic is not present in sufficient amount to cause damage to the foliage by scorching (plasmolysis), it is in this direction only that trouble arises when the leaves are occasionally affected by spraying with arsenate of lead, especially in the case of the home-made material when badly prepared.

The effect of solutions of soft soap upon arsenate of lead suspensions was studied by preparing the mixture in different ways, filtering, after allowing to stand for about half an hour, and determining the soluble arsenic in the filtrate as follows. The latter was oxidised by heating with nitric acid, mixed with magnesia mixture and then rendered strongly alkaline with ammonia. After standing for twenty-four hours the solution was filtered, the last portions of the precipitate of ammonium magnesium arsenate being washed on to the filter paper with a little of the filtrate. After washing the residue with ammonia (1 part .88 NH_3 to 3 parts water) until the washings

give no reaction with nitric acid and silver nitrate, the precipitate was ignited with the usual precautions and weighed as magnesium pyroarsenate. On account of the solubility of the magnesium ammonium arsenate, an addition was made to the weight obtained of .001 gram for each 16 cc. of filtrate (not washings). (*See* Dict. of App. Chem., Vol. I., p. 294.)

In Experiment I., a preparation of arsenate of lead was made by adding a solution of lead arsenate (7 ozs. to 5 gallons water) to a solution of arsenate of soda (3½ ozs. to 5 gallons water). No soft soap was added.

In Experiment II., arsenate of lead was made by adding a solution of lead acetate (7 ozs. to 2½ gallons water), to a solution of arsenate of soda (3½ ozs. to 2½ gallons of water). Five gallons of a 1 per cent. soft soap solution was then added to the mixture.

In Experiment III., 7 ozs. of lead acetate in 2½ gallons of water was added to 2½ gallons of 1 per cent. soap solution and 3½ oz. of sodium arsenate in 2½ gallons of water was added to 2½ gallons of 1 per cent. soap solution. The solutions were then mixed.

In Experiment IV., a proprietary lead arsenate paste was thoroughly mixed with water in the proportion of 1 lb. paste to 50 gallons water.

In Experiment V., another sample of the same paste was mixed with half the above quantity of water (*i.e.*, 1 lb. to 25 gallons), and then an equal volume of 1 per cent. soft soap solution was added.

In each case the liquid was filtered after half an hour, and the soluble arsenic in the filtrate determined with the following results. (See Table on next page.)

As a clear filtrate, free from suspended matter, could not be obtained in the last experiment with the proprietary paste, it was impossible to determine chemically the amount of soluble arsenic in solution. In order to test whether there was any noteworthy increase in the amount of soluble arsenic when soap solution is employed in place of water in the case of arsenate pastes, a gallon of the two liquids as prepared in Experiments IV. and V. were handed to Mr. Theobald to be directly sprayed, and the results compared. It was found that in neither case did any scorching or other damage follow

Details of Mixing.	Filtrate.	Percentage sol. Arsenic in Filtrate.	Remarks.
Experiment I.—Lead acetate solution added to sodium arsenate solution. No soap	Clear	.016%	
Experiment II. — As in Experiment I., but with half quantity of water. Made up to volume by addition of equal quantity of 1% soap solution	Slightly opalescent	.017%	The texture of the precipitate was not altered by the soap.
Experiment III.—As in Experiment I., but 1% soap solution used in place of water	Clear after four filtrations	.026%	The precipitate was very curdy and sticky, quite unsuitable for spraying.
Experiment IV. — Lead arsenate paste mixed with water in correct proportions	Clear	.013%	
Experiment V. — As in Experiment IV., but 1% soap solution used in place of water	Impossible to obtain clear, even after twenty filtrations	Not determined.	Precipitate not sticky, but was partly in a very fine state of division.

on the applications, even in the case of such delicate leaves as those of Cox's Orange Pippin and William and Jersey Pears.

Conclusions.

The addition of a 1 per cent. soap solution to lead arsenate, either home made or in commercial form, does not lead to any appreciable increase in the amount of soluble arsenic. In the case of the home-made material, however, soap solution must not be used for *making up the lead acetate and sodium arsenate solutions in place of water,* as not only is there a marked increase in the soluble arsenic, but in addition the precipitate is obtained of such a texture and consistency as to render impossible its application by spraying. The curdiness of the precipitate is probably due to the fact that the lead soap produced on adding the soap solution to the lead acetate

is not completely converted into lead arsenate on adding the sodium arsenate, the final precipitate consisting of a mixture of lead arsenate and lead soap, a quantity of soluble arsenate equivalent to the lead soap remaining in solution. The addition of soap solution to lead arsenate pastes does not, however, lead to the formation of any lead soap, as deduced by the unchanged texture of the precipitate, and the absence of any increase in the soluble arsenic.

SOME OBSERVATIONS ON THE STORING OF CALCIUM CYANAMIDE.

By A. H. Burgess and D. R. Edwardes-Ker.

As nitrogen is the valuable constituent of Calcium Cyanamide, it is important to know the proportion of this substance lost when the fertilizer is stored, how this loss, if any, may be minimised or prevented.

Different investigators on the subject have come to various conclusions with regard to this loss of nitrogen; some say there is no loss, or that the loss is only apparent and due to gain in weight caused by the absorption of CO_2 and water. The majority, however, are of the opinion that Cyanamide does lose nitrogen on storing, and losses of from .01 per cent. to .04 per cent. per day have been stated. Moisture is regarded, by practically all who found loss of nitrogen, as the factor or one of the factors causing this loss; others conclude that CO_2 is necessary in addition to the moisture. It is interesting to note, however, that manufacturers now treat the Cyanamide with a mineral oil, which latter surrounds the particles, keeping them drier and protecting them from the CO_2 of the air, and it was on this oiled material that the experiments recorded below were carried out.

A preliminary experiment showed that Calcium Cyanamide stored in open air apparently lost nitrogen, while some left for the same time in a corked bottle lost no nitrogen. The question to be decided was whether this loss from the exposed sample was real or only apparent and due to absorption of CO_2 and water.

To settle this question, weighed portions of Cyanamide were placed in air, protected by loose covers; these samples were taken at intervals and the nitrogen estimated by the Kjeldahl method, the percentage in all cases being calculated on the original weight of the substance. The Cyanamide was

found to lose nitrogen at the average rate of .057 per cent· per day (see Table I.). It also steadily gained in weight, thus making the apparent loss of nitrogen greater.

Attempts were then made to discover the cause of this loss of nitrogen, and the Cyanamide was stored under various conditions, as described in detail below.

I.—Moist Air Free from CO_2.

Weighed portions of Cyanamide were placed in closed vessels containing caustic soda solution ; the atmosphere was therefore kept moist but free from any CO_2. If moisture were the cause of the loss, the percentage lost per day would be greater than in air, for the moisture under these conditions is higher than that present in the air. The samples were removed at intervals and the nitrogen estimated ; they showed no appreciable loss of nitrogen, but gained in weight considerably, thus causing a considerable *apparent* loss. Thus moisture alone is not responsible for the loss which is found to take place in the air.

II.—Dry Air Containing Excess of CO_2.

Weighed portions of the substance were placed in desiccators into which was passed some CO_2 and the whole kept dry by a layer of sulphuric acid. If CO_2 were the cause of the loss of nitrogen a marked increase in the amount lost would be expected from these samples where much more than the normal amount of CO_2 was present in the atmosphere in contact with the substance, but this was found not to be the case, and therefore it was concluded that CO_2 alone was not the factor causing the loss.

These samples also showed practically no change in weight, so it seems that moisture is the chief cause of increase in weight, which of course lowers the percentage of nitrogen although it causes no loss.

III.—Moist Air Containing Excess of CO_2.

Weighed portions of the Cyanamide were placed in closed vessels over water saturated with CO_2, in an atmosphere containing excess of CO_2, as it was thought that possibly the moisture and CO_2 working in conjunction caused the loss of nitrogen. On estimating the nitrogen it was found that practically none was lost and in any case it was less than

TABLE I.

No.	Days Stored.	% Gain in Weight.	Method of Storing.	Original % N.	% Nitrogen Calculated on Original Weight.	% Nitrogen Lost per day.	% Nitrogen Calculated on Final Weight.
1	7	3.04	In air	18.97	18.66	0.0473	18.11
2	25	7.95	,,	18.97	17.03	0.0776	15.77
3	36	10.84	,,	14.184	12.293	0.0525	11.09
4	64	16.12	,,	14.184	12.179	0.0313	10.48
5	65	16.46	,,	18.97	14.00	0.0764	12.02
6	28	0.0	Dry Air + CO_2	14.184	13.966	0.0077	13.966
7	60	0.43	,,	14.184	13.976	0.0034	13.915
8	66	0.39	,,	14.184	13.957	0.0034	14.01
9	25	37.43	Moist air, free from CO_2	14.184	13.90	0.0113	10.12
10	40	165.40	,,	14.184	12.98	0.030	4.89
11	83	33.27	,,	14.184	14.25	0.0	10.69
12	20	118.35	Moist Air + CO_2	14.184	13.67	0.025	6.25
13	23	84.40	,,	14.184	14.12	0.0	7.57
14	42	—	In Corked bottle	18.97	18.97	0.0	18.97
15	240	—	,,	14.184	14.157	0.0	14.157

was lost in any sample which was exposed to air. If moisture and CO_2 were the cause of the loss, the amount lost from these samples must have been much greater than the loss found when the substance was stored in air.

IV.—In Corked Bottles.

The material was stored in corked bottles for a considerable period and then the nitrogen was estimated ; it was found to contain the same percentage of nitrogen as it did when placed in the bottles, and so had lost no nitrogen. The paper-lined bags in which Calcium Cyanamide is now supplied approximate fairly closely to the condition of a corked bottle, and probably no loss, or very little loss, takes place from the substance in them as long as they are not opened.

Conclusions.

The conclusions which may be drawn from the above experiments are as follows :—

(1) Calcium Cyanamide loses nitrogen at a fairly rapid rate when exposed freely to the atmosphere in thin layers.

(2) Loss of nitrogen is apparently not caused by either moisture or CO_2, or by both of these acting together.

(3) There is no loss of nitrogen when stored in air-tight vessels, and therefore the loss noted when exposed to air is probably caused by some atmospheric agent.

(4) Moisture causes a fall in the percentage of nitrogen owing to the increase of weight, brought about by the absorption of water by the substance, but it does not cause any real loss of nitrogen.

(5) Calcium Cyanamide should be worked into the soil as soon as possible after its application to minimise the loss of nitrogen caused by exposure to the atmosphere.

(6) It might at first be inferred that the loss of nitrogen on exposure to air was due to the fact that the atmospheric layer in contact with the material is being constantly removed and renewed, whereas under the conditions of the experiments described above, the effective atmosphere is decidedly limited in extent. If, however, the loss in the open air is due to removal of ammonia by air-currents, a similar and possibly greater loss would have been observed in Experiments 6, 7 and 8, in which any ammonia liberated would have been progressively

absorbed by the layer of sulphuric acid present. In these three experiments, however, the loss was only about one-tenth of that observed when stored in air for equal lengths of time. (See Table II., in which comparative results are bracketed together.)

TABLE II.

No.	Time.	Conditions.	% Nitrogen lost per day.
2	25 days	In air	.0776
6	28 ,,	Dry air + CO_2 (over H_2SO_4)	.0077
4	64 days	In air	.0313
8	66 ,,	Dry air + CO_2 (over H_2SO_4)	.0034

NOTE ON "LIME AND SULPHUR."

By D. R. Edwardes-Ker.

There have appeared lately in various horticultural journals references to the employment of a mixture of lime and sulphur and recommendations for its use in the treatment of various fungous diseases for which either "flowers of sulphur" or lime-sulphur has been found effacious. The slaked lime and "flowers" are recommended to be used together mixed in equal parts by weight, and the dry mixture is blown on to the affected plants in a similar manner to that in which "flowers of sulphur" is applied.

In order for a mixture of lime and sulphur to have any additional effect to that produced by the two constituents, it is necessary that some chemical action take place between the two components, with production of a compound possessed of a distinct fungicidal value; otherwise there seems to be no advantage in mixing the two constituents and thus diminishing the effect that the sulphur would have if applied alone, for slaked lime by itself has certainly no value as a fungicide. (*Vide* p. 422 of this *Journal.*)

In order to test the question as to whether any chemical reaction takes place between lime and sulphur when intimately mixed in equal proportions, the following experiments were carried out.

Two lots of 4 grams "flowers of sulphur" and 4 grams quicklime (powdered) were intimately mixed and placed in two beakers left open to the atmosphere. At the end of fourteen days the contents of one of the beakers was examined qualitatively for sulphides, sulphates, thisulphates or any soluble sulphur compounds—by extracting the mixture with cold water and testing the aqueous extract as follows :—

For Sulphides, a little caustic soda is added to a portion of the extract, and then a few drops of sodium intraprusside solution.

Absence of any pink coloration denoted absence of sulphides.

For Sulphates, the aqueous solution is acidified with hydrochloric acid and barium, chloride solution added and Bac. solution added. No precipitate was obtained, indicative of absence of sulphates.

For other soluble sulphur compounds, some of the aqueous extract was boiled with nitric acid, and the solution so obtained tested as above for sulphates, of which none were found. Any soluble sulphur compounds would have been oxidised to sulphate by the treatment with nitric acid.

The amount of sulphur still existing in the unchanged form in the mixture in the other beaker was then estimated as follows :—

The material was placed in a cartridge in a Soxhlet extractor, and extracted with carbon bisulphide for several hours. The sulphur dissolved out was determined by distilling the carbon bisulphide from the flask and weighing the residue of sulphur left after drying in the steam oven. A portion of the original sulphur, *i.e.*, that in the amorphus form, being insoluble in carbon bisulphide, remained in the cartridge with the lime. To estimate this the contents of the cartridge were treated with dilute hydrochloric acid, and the material remaining, consisting of sulphur and a small quantity of silica from the lime employed, was weighed, ignited and weighed again. The residue after ignition represents the silica, and the loss on ignition the sulphur.

The experimental figures were as follows :—

Weight of sulphur (dry) originally taken	=	4.000	grams.
,, ,, ,, recovered, sol. in CS_2	=	3·7445	,,
Weight of insol. S. + Silica ..	=	·3055	,,
Weight of Silica	=	.0340	,,
∴ Weight of insol. S.	=	.2715	,,

Total weight of sulphur recovered :

$$= 3·7445 + .2715 = 4.0160 \text{ grams.}$$

In a second series of experiments, two lots of 4 grams each of slaked lime and "flowers of sulphur" were allowed to stand

after mixing for four weeks, and at the end of that time, on testing as above for sulphides, sulphates and other soluble sulphur compounds, no traces of these were found.

In order to account for the original amount of sulphur taken, the mixture in one case was treated with dilute hydrochloric acid, it having been previously found that the sample of lime taken in this case was completely soluble in hydrochloric acid. The residue was weighed direct as sulphur.

Weight sulphur taken	=	4.000 grams.
less moisture	=	1.019 ,,
Weight dry sulphur taken	=	3.981 ,,
,, dry sulphur recovered	=	3.956 ,,

In a third series of experiments, ten grams of quicklime and ten grams of "flowers of sulphur" were mixed and were kept in a loosely covered beaker for three months. The sulphur in the free state was estimated by digesting the mixture with dilute hydrochloric acid, as described above.

Weight of dry sulphur taken	=	10.00 grams.
Weight of dry sulphur recovered after one filtration	=	9.9704 ,,
Ditto on re-filtering cloudy filtrate	=	.0270 ,,
Total sulphur recovered	=	9.9974 ,,

The filtrate was examined for sulphates, and of these .1005 grams as barium sulphate were found to be present. As the amount of sulphate as barium sulphate originally found in ten grams of the lime taken was .1060 grams, it was concluded that there had been no sulphate formed during the three weeks during which the mixture of lime and sulphur had been kept.

It was concluded from these three experiments, therefore, that there is no chemical action on mixing either quicklime or slaked lime with "flowers of sulphur," and that consequently, considered from a chemical point of view, there is no obvious advantage in adding lime to "flowers of sulphur" in those cases in which the latter substance is to be used as a fungicide.

SOME NOTES ON THE SALE OF MILK.*

PRECAUTIONS TO AVOID PROSECUTION AND CONVICTION UNDER THE SALE OF FOOD AND DRUGS ACTS.

By D. R. EDWARDES-KER, B.A., B.Sc.

From enquiries that reach milk experts and analysts from time to time with regard to the analysis of milk samples taken by Government Inspectors, it is evident that the working and meaning of the Food and Drugs Acts is still incompletely understood by many farmers and dairymen, and it may be advisable herewith to explain the Act, to give suggestions as to the necessary precautions to be taken to avoid trouble in this direction, and to indicate the lines upon which to proceed in the event of a prosecution in the case of a milk sample which, while below the legal requirements, is known—by the vendor at least—to be unadulterated and unskimmed. Owing to the value of milk as a human foodstuff, and the ease of its adulteration, either by (1) removing cream (2) adding water (3) adding skimmed or separated milk, legislation has been introduced by the Board of Agriculture, in exercise of the powers conferred on them by the Sale of Food and Drugs Acts, to prevent such adulteration by fixing standards to which all samples of milk offered for sale must conform.

COMPOSITION OF MILK.

The materials in milk of value as foods may be divided into two classes; (1) fat, which is the main constituent of cream; and (2) solids other than fat, which make up a large proportion of the "curd" of milk. It is in connection with

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the amount of these two classes of substances that legislation deals. As the result of a very large number of analyses of different milk samples, made prior to the framing of the Act, it was found that genuine milk does not often contain below 3.2 per cent. of fat or 8.9 per cent. of solids not fat. It was therefore decided that, by fixing the legal minimum for butter-fat at 3 per cent., and for solids not fat at 8.5 per cent., the authorities would not be erring on the side of unfairness.

Official Regulations.

The actual wording of the law (Sale of Milk Regulations, 1912) is as follows:—"Where a sample of milk (not being milk sold as skimmed or separated, or condensed milk) contains less than 3 per cent. of milk-fat, it shall be presumed for the purposes of the Sale of Food and Drugs Act, *until the contrary is proved*, that the milk is not genuine, by reason of the extraction therefrom of milk-fat, or the addition thereto of water. Where a sample of milk (not being milk sold as skimmed, or separated, or condensed milk) contains less than 8.5 per cent. of milk solids other than milk fat, it shall be presumed, for the purposes of the Sale of Food and Drugs Acts, *until the contrary is proved*, that the milk is not genuine, by reason of the abstraction therefrom of milk-solids other than milk-fat, or the addition thereto of water."

An important feature of the Regulations is the clause printed above in italics, by which milk vendors who are summoned under the Act are provided with a means of avoiding conviction in many cases. Milk is, of course, a substance of very variable composition, and may in certain cases fall in composition considerably below the legal limits (3 per cent. butter-fat, 8.5 per cent. solids not fat), and it was owing to the knowledge of this fact that under certain conditions, milk, though unadulterated, may be of abnormal quality, that the above clause was included.

Evidence for Defence.

The seller of milk which is found to be below the legal requirements will not as a rule, therefore, be convicted, provided that he can prove to the satisfaction of the magistrates *that the milk in question is sold in exactly the same*

condition as it was obtained from the cows, and it is along these lines that sellers of milk which is known to be untouched should proceed for their defence in the event of an action being taken against them. The milk must be traced right through from the cow to the inspector who takes the sample, and it must be satisfactorily proved that the milk has been in charge of, and under the observation of, trustworthy persons throughout. This tracing of the observation of the milk in transit is not always so easy to prove, and it is advisable to secure the services of a solicitor to conduct the defence, as in those cases in which the necessary proofs are forthcoming, no bench of magistrates would convict. It should be mentioned here, however, that it is not sufficient to establish the above chain of evidence, and prove that the milk has been unadulterated and delivered in its natural condition, if there has undoubtedly been mismanagement of the cows in question—as, for example, by the excessive feeding of wet grains, watery root crops, etc. This constitutes legally an adulteration of the milk through the cow, and as, obviously, the question as to whether there has been mismanagement or not is largely one of personal opinion, the defendant is to a great extent at the mercy of the magistrates if this side of the case arises.

Precautions in Purchasing Milk.

Any circumstances that would render evidence difficult of proof should be avoided—as, for example, the purchasing of odd samples of milk from different farmers and dairymen Those vendors who sell milk from their own cows only, have naturally the easiest case to prove ; those who buy their milk from others should procure it from reputable persons only, and from as few sources as possible, so that in cases of prosecution there may be as little difficulty as possible in proving no mismanagement of the cows, or in producing reliable evidence of supervision of the milk from the cow to the consumer. The question of warranty as a defence is one that every dairyman compelled to purchase all or part of his milk should consider. If milk is purchased under a warranty, it is guaranteed to be delivered to the daiyrman with a composition up to legal requirements, consequently, in the event of a summons being taken out in respect of a retail sample, the

retailer has only his own case to consider, and has only to prove that he delivered the milk in the same condition as he received it, while the *onus* of the proof of previous treatment falls upon the person from whom it was purchased under warranty.

Official Analysis.

Generally the analysis of the official sample as stated upon the summons should not be doubted, for the lines upon which the defence should be conducted are, firstly, to trace the milk right through, as outlined above, and then to attempt to explain the deficiencies found on analysis, rather than to question the correctness of such analysis.

Analysis by Vendor.

It is necessary here to insert a warning against the use of the creamometer, or the even more unsatisfactory practice of judging of the quality of milk by observation of the amount of cream which rises to the surface on standing. No reliable information—in fact, no idea whatever—can be arrived at in this way as to whether the milk is up to standard or not, and dairymen are strongly advised against such rough-and-ready methods of computing the quality of the milk for which they are responsible.

An accurate, rapid, and easy method of estimating the percentage of fat in milk is possible by the use of the Gerber milk tester or other similar pieces of apparatus, which are sold by various firms. Together with the instrument are supplied, at a moderate price, the materials and full instructions for working; and all dairymen and others connected with the sale of milk should safeguard their interests by employing this apparatus regularly. Not only is an accurate daily knowledge of the quality of milk sold thus possible, but the evidence that the milk is regularly tested in this way is, in the case of a legal action, of the greatest value in confirming the honesty of the defendant, and undoubtedly influences the authorities favourably. The estimation of the solids-not-fat can only be carried out by an analyst, but as the cases in which the solids-not-fat are below standard, while the fat is up to requirements, are quite exceptional, a periodical

determination of the fat only affords an almost complete safeguard.

NATURAL CAUSES OF LOW QUALITY MILK.

There are given herewith some of the more important factors that may result in a low quality of milk:

1. *The dairy herd is small—say, five cows only.*—The smaller the number of cows in the herd, the greater the likelihood of the milk being at times below the standard.

2. *Unequal intervals between the milkings.*—In this country the morning milking is generally performed about 5 or 6 a.m., and the afternoon milking about 2 to 3 p.m., but in some cases as early as mid-day. As a result, the intervals between successive milkings are very unequal—say, eight or nine hours between morning or evening, and fifteen or sixteen between evening and next morning. As after a long period between milkings it is always found that the milk is poor in quality, and as, conversely, the milk is always richer after a short period, it is necessary, in order to secure a fairly uniform supply, that the times of milkings on any one day should be as far apart as possible.

3. *The presence in the herd of a large number of cows that have recently calved.*—Cows that have freshly calved give a large quantity of milk, but the quality is generally low.

4. *The change from winter to summer feeding.*—The effect of grass is to produce a lowering of the quality of milk, the change being most marked immediately after the cows go out. Excessive root or wet grain feeding may produce the same result.

5. *Incomplete stripping.*—Owing to the fact that the last traces of milk which drain from the udder contain often up to 10 per cent. of fat, care should be taken to milk the cows absolutely dry.

NOTES ON LINSEED.

I. LINSEED AS A FARM CROP.

J. VARGAS EYRE.
T. E. WILSON DOBSON.

LINSEED AS A FARM CROP.

Linseed and linseed cake have for long been regarded as food of special value for all stock, more especially for "milking cows" and "fatting bullocks," and as a "finishing off" food seems to be quite unique. Ground linseed has now become of very great importance in rearing calves. At the price to which these commodities have risen during recent years they have become so expensive as to preclude their general use on such a scale as would be desirable. The question therefore arises whether the farmer can grow linseed for his own consumption at a smaller cost than he can buy it for under existing conditions. This question seems to be of growing importance to Agriculturalists and has led to numerous experiments being made to ascertain the best conditions for growing linseed in this country. From practical experience gained during the past three seasons it is now possible to put forward the following notes and recommendations for growing linseed successfully as a farm crop.

Considerations of Soil.

Linseed requires no special kind of soil; it flourishes well on any good medium land. Provided that the land is clean its selection is of minor importance compared with its proper preparation prior to sowing the seed. Although it may be said that land which is clean and well adapted to the cultivation of barley is suitable for linseed, the best results are obtained on a medium loam where the sub-soil is stiff—a good wheat bottom being eminently suited.

Place in Rotation.

In linseed growing countries many different rotations are adopted, but a good practice is to sow linseed after a corn crop. Linseed does well after wheat, and wheat does well after linseed, and the usual custom is to grow linseed after a straw crop of some kind, although not infrequently it finds a place after clover, a practice which at the present time is followed in Ireland where flax is grown for fibre. If sown early and a fair season follows, linseed harvesting may be completed by the end of July and a "catch-crop" obtained in the same year.

When the land is heavy and linseed follows wheat, autumn ploughing is always regarded as of the utmost importance. Light soil must be consolidated so that it will retain moisture easily and provide a firm seed-bed ; a condition which is best attained by following with linseed after a root or green crop has been fed off by sheep. Under these circumstances it is very advantageous to sow "seeds" with the linseed.

Most authorities agree in not growing linseed too frequently on the same land, because a condition of soil sickness sets in. The usual interval between two crops is about seven years.

Preparation of the Land.

Great stress must be laid upon the necessity of having the land deeply worked and firm with but a shallow surface layer to cover the seed after sowing. This is of importance, because the linseed crop grows very rapidly—the growing period extending over some ten weeks only—and the most desirable conditions are those which cause this rapid growth to be both continuous and uniform. To obtain these conditions the land should be deeply ploughed in the autumn or early winter and allowed to remain until near the time of sowing, except when the crop is to follow clover or is to be on heavy land, when it is advisable to broadshare. Suitable cultivations should be carried out just prior to sowing so as to obtain a firm seed-bed and a fine tilth.

Manuring.

Up to the present time there appears to be very little information of a reliable character which throws light on which

are the most suitable manures to use for the production of linseed. It is not at all certain that the treatment recommended for flax when grown for fibre is the most suited to the requirements of the linseed crop. As far as our experiments have gone it seems that super-phosphate with potash is the best combination of artificials to use and is better than either of these manures by themselves. When farmyard manure is used it should be applied to a previous crop. It is no longer seriously maintained that flax is an exhausting crop in the sense that it draws more from the land than do other crops.

Variety of Seed to Sow.

The selection of seed for sowing is an important point, as it is very necessary to employ only the very best seed, choosing that which is bright, plump and clean. The best plan is to choose one's seed merchant with care, so that one may be reasonably confident of getting the best quality seed on the market.

Of the several types of linseed which may be grown profitably in this country as a seed crop, our experience goes to show that the best is that known as *La Plata* or *Plate Linseed.* This is one of the medium large seeded varieties which grows to about two feet in height and exhibits a marked tendency to branch at the base. When both yield of seed and oil-content are taken into consideration, *Plate Linseed* is found to be a better type to grow than either *Morocco Linseed, Steppe Linseed* or *Dutch White Flowering Linseed ;* these latter following in the order given.

When making use of these imported seeds for sowing purposes it is necessary either to carefully dress the seed free from weeds or to stipulate that this must be done thoroughly by the merchant, otherwise very serious trouble may be encountered by letting loose foreign weeds on the farm.

Time of Sowing.

The best advice is to sow as early as possible, as early as the soil and weather will permit, so that the seed will germinate slowly and have a good start while moisture is in the top soil.

Fear need not be entertained that moderate frost will damage the plant—it is quite able to withstand without injury several degrees of frost.

Usually it is possible to sow on light land at the end of March or the beginning of April, but on heavier land it is seldom possible to get the seed sown before the end of April. There are, however, many varying influences which have to be taken into account and only the farmer can say when his land is in suitable condition for receiving the seed; the matter of importance being to get it in as early as possible. Linseed is a crop which is rather easily affected by drought in its early stages of development.

Mode of Sowing.

As with other crops, the seed may be sown either by broadcasting or by drilling, but owing to the slippery nature of the seed it is seldom possible to effect uniform distribution except by expert hands. This means that broadcast sowing is generally best accomplished by using the fiddle.

Drilling possesses the distinct advantage that it ensures the seed being at a uniform depth. A light corn drill may be rendered suitable for the purpose by setting the coulters as close together as six inches. It is found an even better practice to use a seed barrow for sowing linseed.

It is desirable to have the seed buried only to about half an inch or an inch below the surface; light harrowing followed by light rolling being all that is necessary after sowing.

Rate of Sowing.

When deciding at what rate per acre to sow linseed, it is necessary to take into consideration (1) the germination of the seed; (2) the size of the seed; (3) the habit of the plant and (4) the mode of sowing.

The importance of knowing the percentage of dead seeds in any sample of sowing seed will be obvious to all farmers and with linseed it is particularly desirable to have this information, because bad storage may impair the vitality of the seed very considerably. The average percentages of

live seeds in the samples of imported linseed which were examined last year and this year were :

	1913.	1914.		1913.	1914.
Plate Seed	72 ;	100.	Steppe Seed	94 ;	100
Morocco Seed	98 ;	100.	Dutch Seed	92 ;	37.

The size of the individual seeds must also be taken into consideration when deciding how much to sow per acre, because some large seeded varieties, such as that coming from Morocco, may be easily twice as large as those of a small seeded variety such as Dutch. To give some actual examples, the weight of 1,000 seeds of *Morocco linseed* was found to be 9.96 grams ; that of 1,000 seeds of *Plate linseed* 5.98 grams ; that of *Steppe linseed* 4.91 grams, and that of *Dutch linseed* 4.25 grams, so that if the germination of these varieties were the same a given weight of the largest (Morocco) would give less than half the number of plants as would be given by the same weight of Dutch seed. This is obviously of great importance, although it is a point which is seldom taken into consideration by writers on agriculture.

Although of less importance, it is also desirable to bear in mind that some varieties of linseed differ in habit from others, for instance, Dutch seed and to a less extent Morocco seed, give plants which show little tendency to branch at the base—being, in this respect, unlike Plate seed. This means that to get a full crop less seed of the latter variety may be used.

It is generally understood that drilling requires less seed than broadcasting and this need only be referred to here.

The following are the quantities of seed per acre recom mended for broadcast sowing when the germinating property is that already given for 1914.

Plate Seed	91 lb.	Steppe Seed	86 lb.
Morocco Seed	166 lb.	Dutch Seed	219 lb.

Weeding.

Provided the land is moderately clean it is not necessary to carefully weed the crop as is customary with a flax crop ; it is sufficient to weed once and to keep the larger weeds down by spudding. Weeding, however, should be done at a time when the ground is moist, so as to avoid, as far as possible, damaging the young linseed plants. It is desirable to remove

gross weeds such as dock thistles, convolvulus and dodder at an early stage, because linseed, being a crop which affords less shade to the ground than other grain crops, weeds are able to make more headway.

Harvesting.

Linseed continues to flower for some time and consequently ripens unevenly—the plants carrying ripe and green capsules even at harvest time. This fact is not detrimental to good harvesting, because, like wheat, it ripens in the "shock." It is everywhere agreed that the best practice is to harvest linseed when the stems have turned yellow and the lower leaves have fallen. At this stage an examination of the seeds within the older capsules show them to be uniformly pale brown in colour.

It is not wise to allow the crop to stand until the majority of the capsules are dead-ripe, because considerable loss of seed thereby ensues when the crop is harvested. Careful handling is more necessary with the linseed crop than with other grain crops, because the seed "bolls" become entangled and are easily detached from the straw.

If the area is small it is obviously the best course to cut it with scythe or sickle, but with larger areas an ordinary reaping machine requires very little adjustment to deal with the crop satisfactorily. The sheaves should be made up small so as to allow drying to proceed rapidly, and these should then be "shocked" together in the ordinary way. Except when the weather is very dry, it is best to turn the "shocks" so as to make sure of the whole being thoroughly dry before being carted and stacked. Considerable loss of seed can be avoided by spreading a sheet on the floor of the wagon when carting.

Threshing.

The best method of threshing linseed at the present time is by means of an ordinary threshing machine and to achieve the best results the following adjustments are recommended. About two-thirds of the cavings riddle should be covered with a piece of sacking to prevent any large amount of the savings falling through the riddle along with the seed and

chaff. The ordinary size riddle being so large as to allow unbroken seed " bolls " to pass through with the seed, a three-sixteenth-inch. "Chob" riddle is recommended. The unbroken seed " bolls " should be passed through the drum a second time. Unless the drum of the machine be set close and a high speed maintained, and the straw be carefully fed into the machine, the straw may have to be put through a second time to remove all the seed. Linseed being much smaller than the seed of other grain crops, only the finest riddles should be used.

Where only a small area of linseed has to be dealt with threshing may be accomplished with a flail or by beating with a sloped mallet such as is used in Holland and Belgium. The latter has the advantage that threshing is completed in one operation, all the capsules become broken and the seed set free, whereas, when a flail is used a considerable number of the " bolls " remain whole although detached from the straw, so that it is necessary to crush them to liberate the seed.

After either of these modes of threshing has been followed the seed can be freed from chaff and cleaned thoroughly by passing it through a winnowing machine fitted with the finest riddles.

Straw and Chaff.

Linseed straw is remarkably tough and wiry and for this reason does not make a good litter for stock, because it rots down very slowly. There are, however, several ways of using it profitably. On the farm the straw is valuable for making stack-bottoms, and for the bottom of covered yards ; the wiry nature of the straw being an advantage over ordinary straw for these purposes. It is also very useful for thatching and lasts much longer than either wheat or rye straw.

A very good tough paper can be made from linseed straw and although at present there is only a limited demand for it for this purpose, it is probable that if larger quantities were forthcoming it would be more seriously considered by paper makers and advantage accrue thereby to the growers.

The chaff of linseed consists almost entirely of the remains of the broken seed capsules. It may be fed to stock in the

same way as other grain chaff, ewes being particularly fond of it. It should be observed, however, that as the chaff contains a considerable amount of fibre, it is unsuitable for all kinds of young stock, more particularly lambs.

Grinding Linseed.

Linseed as a food for stock—especially for calf-rearing—is so well known as to need no comment here. It may be used whole or ground into a meal, although probably when ground it is in its best form and in this state the "feed" is more easily prepared. The question arises then, how best to grind linseed, because it sometimes happens when the grinding surfaces are of stone that the mill becomes clogged unless some absorbent material is added. The best material to mix with linseed for this purpose is previously crushed maize in the proportion of one part of maize to seven parts of linseed. This facilitates grinding by absorbing the oil which becomes pressed out of the linseed during the grinding operation.

REPORT ON

ECONOMIC MYCOLOGY

BY

E. S. SALMON, F.L.S.

CONTENTS

INTRODUCTORY NOTE.

By E. S. Salmon.

During the past year a very large number of diseased plants have been sent in by farmers and gardeners; these have been examined (and where necessary, cultures of the fungus concerned made), and reports sent to the grower as to the nature of the disease and the remedies.

Among the diseases sent in the following have been the most frequent: Apple "Scab" (*Venturia Pomi*); Apple Mildew (*Podosphaera leucotricha*), Apple "canker" (*Nectria ditissima*); Apple "Brown Rot" canker (*Sclerotinia fructigena*); "Bitter Rot" of Apple (*Gloeosporium fructigenum*); "Sooty Blotch" of Apple (*Leptothyrium Pomi*); Pear "Scab" (*Venturia pirina*); Cherry Leaf Curl (*Exoascus minor*); Peach Leaf Curl (*E. deformans*); Plum *Fomes* (*Fomes pomaceus*); Gooseberry "Cluster-cup" (*Puccinia Pringsheimiana*); American Gooseberry-Mildew (*Sphaerotheca mors-uvae*); European Gooseberry-Mildew (*Microsphaera Grossularieae*); Wheat Rust (*Puccinia glumarum*); Celery "Blight" (*Septoria Petroselini* var. *Apii*); Potato "Scab" (*Oospora scabies*); "Black-leg" of the Potato (*Bacillus phytophthorus*); *Rhizoctonia* of the Potato; Peach Mildew (*Sphaerotheca pannosa*); Rose Rust (*Phragmidium subcorticatum*); Carnation Rust (*Uromyces caryophyllinus*); Willow-rod "canker" (*Melampsora alii-salicis albae*); Wallflower "Mildew" (*Peronospora parasitica*); Tomato "canker" (*Mycosphaerella citrullina*); Cabbage "Leaf-spot" (*M. brassicicola*); Tomato "Rust" (*Cladosporium fulvum*); Bacterial Rot of Hyacinth; *Fusarium* of Apple-buds (see below, p. 450); Fungous diseases of the Loganberry (see below, p. 474); Bacteriosis of the Potato, and *Cytospora* of the Apple (*Cytospora carposperma*).

Complaints of the "Silver-leaf" Fungus (*Stereum purpureum*) have been frequent, more especially from farms

where the reprehensible practice had been followed of allowing old dead " silvered " trees to remain in the orchard or plantation instead of being grubbed up and burnt.

An outbreak of " scab " on potatoes on a farm near Guildford, Surrey, was investigated, and the disease found to be " corky scab," caused by the fungus *Spongospora Solani*. The variety attacked was the " Eclipse," and the infestation was fortunately not severe. This disease has become of considerable economic and practical importance, since the Governments of many foreign countries are now prohibiting the importation of English potatoes unless they are certified as having been grown on land where no attacks of " corky scab," " wart-disease," or bacterial disease of the potato have occurred.

Isolated outbreaks of the " wart-disease " of the potato (*Chrysophlyctis endobiotica*) have occurred in Surrey, and are under the charge of the Board of Agriculture.

A case of " Crown Gall " on Lucerne, caused by the fungus *Urophlyctis Alfalfae*, was found at Malling, near Maidstone.* This is the first case noted in Mid-Kent, the previous ones having all been in East Kent. I am informed that this disease is very frequent in South America, where Lucerne (" Alfalfa ") is so largely grown.

During the past season outbreaks of the " Brown Rot " fungus (*Sclerotinia fructigena*) have been unusually frequent and severe—Cherries, Plums, and Apples being commonly attacked. There seems clear evidence that this fungus is attacking the Apple with greater virulence than previously, and it is now frequently the cause of a " canker " of the stem. (See below, p. 446.)

A considerable amount of attention has been paid to the life history of the American Gooseberry-Mildew (*Sphaerotheca mors-uvae*) ; the manner of the dehiscence of the *perithecium*, and the time at which this takes place, have been ascertained; these facts which were not previously known are likely to prove of practical importance. Experiments in spraying to keep this mildew in check have been continued with a considerable amount of success. (See below, p. 403.)

* This was brought to my notice by Mr. J. Amos, Superintendent of the College Research Station at Malling.

Numerous enquiries as to the use and properties of the lime-sulphur wash have been received; in several cases samples of the home-made wash have been determined for density.

Samples of Celery seeds suspected of harbouring the *spores* of the Celery "Blight" fungus (*Septoria Petroselini* var. *Apii*) have been microscopically examined for growers.

My assistant, Mr. H. Wormald, has successfully investigated a Bacterial Heart-rot of the Celery, and isolated a bacterium new to Science. A full account of this work appears in the *Journal* of *Agricultural Science*, Vol. VI., p. 203, and a *résumé* is given below (p. 457).

Mr. G. Smith and Mr. G. O. Searle, on obtaining their B.Sc. degree in the University of London, commenced research work in the Mycological Laboratory.

Mr. G. Smith has investigated the infection powers of the potato "blight" fungus (*Phytophthora infestans*) (see below, p. 494).

Mr. G. O. Searle, to whom a Research Studentship has been granted by the Board of Agriculture, is working on the specialization of parasitism in *Erysiphe Polygoni*, the Sweed mildew, and has already obtained some interesting results.

THE AMERICAN GOOSEBERRY MILDEW.

(*Sphaerotheca mors-uvae* (Schwein.) Berk.)

By E. S. Salmon.

In past volumes of this *Journal*, I have recorded the gradual spread of the American Gooseberry Mildew in Kent, since its first outbreak in 1908, and also the steps taken by the Kent County Council to attempt to deal with the disease on the lines laid down by the Board of Agriculture's "American Gooseberry Mildew Orders." Owing to the failure of the measures taken to stop the spread of the mildew, the Kent County Council decided, in October, 1913, to refuse to carry out any longer the Board of Agriculture's Mildew Orders. Previously to this, it must be noted, a deputation of fruit-growers from Kent visited the Board of Agriculture under the following circumstances. Early in 1913, the Maidstone Farmers' Club passed the following resolution: "That this Club and Chamber respectfully urge upon the Board of Agriculture that in view of the experience of practical fruit-growers, that tipping gooseberry bushes has been proved to be useless in the prevention of gooseberry mildew, and that the pest can only be dealt with by spraying, the regulations should be modified so as to omit compulsory tipping, and the Club and Chamber would support a more drastic application of the regulations as regards spraying." It is to be noted that during the winter of 1912-13, a number of growers began to evade the compulsory "tipping" of diseased bushes. In my last Report I wrote: "This year, 1913, the state of things is even more unsatisfactory than in 1912. The total affected acreage is considerably more, and the proportion where the autumn 'tipping' of affected shoots as directed by the Board's Orders has *not* been carried out is considerably larger, for in January, 1913, no less than 1,586 acres (or nearly

one half of the total affected area) which should have been pruned by October 31st, 1912, were still unfinished. . . . Assuming that the measures officially decided upon are satisfactory, the failure to enforce them during the past few years has made the work in connection with the Board's 'American Gooseberry Mildew Orders' a waste of public money.' "

It should be noted, too, that at this time, *i.e.*, early in 1913, some fifteen or twenty summonses were on the point of being served on some of the largest farmers for not carrying out the " tipping " in winter in a satisfactory manner.

The Maidstone Farmers' Club then arranged a meeting of delegates at the Board of Agriculture, and an astonishing thing happened. Although for several years past the Board have been insisting upon the absolute necessity of the winter " tipping " being strictly carried out, and had themselves helped to secure convictions against farmers in other counties who had not complied with the requirements of the " Orders," the Board's representative at this meeting (at which no Government scientific advisor was present) suddenly abandoned the whole position, exempted from all penalties those farmers in Kent who had not carried out the provisions of the Order, and granted their wish that they might substitute spraying for " tipping," on their signing an agreement with the Board.

In June, 1913, the Maidstone Farmers' Club were able to send to their members the following letter :

" It has been strongly felt by the Members of this Club and Chamber that tipping as a preventive of Gooseberry Mildew is a very disastrous and unprofitable method, rendering the bushes in a short time almost useless.

" As an alternative the Board of Agriculture, upon representations being made to it by this Club and Chamber, and after several Conferences with its Delegates upon the subject, has consented to allow Growers in Kent to substitute spraying for tipping as a preventive of Gooseberry Mildew experimentally during the years 1913 and 1914, upon their signing and forwarding the enclosed agreement to the Board at the address given therein.

" The Board has shown itself to be extremely anxious to o-operate with Growers in every way in order to discover

the best means of safeguarding gardens from the ravages of this disease, and it is hoped therefore that many Growers will take advantage of the alternative offered them under the Agreement, in order that the experiment may be as comprehensive as possible, and that it may lead to the adoption of a safe and economic means of combating the disease."

The Agreement mentioned in this letter is as follows :

I,...................... of.............................. in the County of Kent, hereby undertake to keep a careful observation either in person or through the agency of a trustworthy foreman, on all the gooseberry and currant bushes on land in my occupation, and to report forthwith the appearance of the summer-stage of American Gooseberry Mildew on any of the said bushes to the Head of the Horticulture Branch of the Board of Agriculture and Fisheries, Craven House, Northumberland Avenue, London, W.C. I also undertake to spray with a suitable fungicide approved by an Inspector of the Board or the Local Authority, every garden in which such disease appears, not less than four times if it appears in April, three times if it appears in May or before June 21st, twice if it appears after June 21st, each spraying to be conducted in a thorough manner and to the satisfaction of an Inspector.

I will keep a true and complete record of every spraying of all my gooseberry and currant bushes, whether carried out before the disease appears or after, showing the actual date of such spraying, the materials used, the acreage sprayed, the time taken, and the number of men employed, and all the information shall be shown to any Inspector of the Board or the Local Authority at any reasonable time, and full facilities given him for making a copy of the entries. I undertake to notify the Head of the Horticultural Branch as far as possible of the actual date when I propose to spray any garden in which disease has appeared.

I undertake to destroy by fire or other suitable means any diseased fruit as soon as possible after it has been attached, and to remove and destroy on or before October 31st each year, all diseased suckers.

I undertake to carry out all these requirements carefully and conscientiously during the years 1913 and 1914, and to give the Board of Agriculture and Fisheries and the Local Authority of Kent and their respective Inspectors every information and assistance in my power that will lead to the discovery and eradication of the aforesaid disease, provided that I shall not be required to prune, tip, or otherwise cut any gooseberry or currant bushes growing on land in my occupation during the years 1913 and 1914, and I understand that this provision shall not hold good if I fail to carry out any material part of this undertaking.

A number of farmers in Kent signed the above agreement, but as could have been predicted by anyone familiar with all the circumstances, the stipulated conditions are not being carried out, and the growers are finding that the mildew cannot be dealt with by spraying alone.

In October the Kent County Council took the not unexpected step of declining to appoint any longer County Inspectors to carry out the Board of Agriculture's American Gooseberry Mildew Orders. As far back as 1910, the Committee of the Kent County Council reported as follows: "The Reports of the Inspectors with regard to the disease are very discouraging. The re-appearance of mildew in those plantations in which it was supposed to have been eradicated by the vigorous measures of pruning and spraying which were adopted is an especially discouraging fact, which raises a doubt whether these remedies will ever be really effective in stamping out the disease. Unless the remedies adopted are such as will be effective, whatever the weather may be, the question arises whether the money which is being spent in the enforcement of these Orders is not being wasted. For three years the Council's Inspectors have been carrying out with zeal and care the requirements of the Board of Agriculture, with the disappointing result that the disease now affects a much larger area than it did in 1908."

In 1910 the affected acreage in Kent was 2,852 acres; in 1913 it was no less than 3,593 acres.

The Inspector's Reports, presented in October, 1913, showed the amount and intensity of disease in each district as follows. With regard to the intensity of disease, "*bad*" signifies that above 40 per cent. of the bushes were affected; "*general,*" between 40 and 15 per cent. affected; "*slight,*" less than 15 per cent. affected; and "*few,*" from 1 to 10 bushes affected.

Swanley District:—

The disease first appeared on May 7th, and the following cases were recorded in each month:—

May	..	..	20 cases.
June	..	..	132 ,,
July	..	..	174 ,,
August	..	..	130 ,,
September	..	..	11 ,,

giving a total of 467 infected plantations, of which 77 (affecting 112 acres) were new cases.

The following table gives the intensity of the disease :—

Year.	Bad.	General.	Slight.	Few.	Total.
1908	393	231	378	232	1234 acres.
1909	122	84	250	431	887 ,,
1910	279½	208½	635	263½	1387 ,,
1911	162	63	403	445	1073 ,,
1912	228	200	335	534	1297 ,,
1913	131½	260	384	502½	1277 ,,

Maidstone District :—

The disease first appeared on April 14th, and the following cases were recorded in each month :—

April	..	..	1 case.
May	..	..	27 cases.
June	..	..	123 ,,
July	..	..	264 ,,
August	..	..	198 ,,
September	..	..	81 ,,
October	..	..	5 ,,

giving a total of 699 infected plantations.

The following table gives the intensity of disease in each year :—

Year.	Bad.	General.	Slight.	Few.	Total,
1908	225	149	330	316	920 acres.
1909	130	65	148	145	488 ,,
1910	222	247	462	295	1226 ,,
1911	171	223	474	259	1127 ,,
1912	152	394	529	397	1472 ,,
1913	130	390	645	717	1882 ,,

Of the total infected (1,882 acres), newly infected plantations account for 380 acres.

Sandwich District :—

The disease first appeared on April 19th, and the following cases were recorded in each month :—

April	..	..	11 cases.
May	..	..	50 ,,
June	..	..	133 ,,
July	..	..	83 ,,
August	..	..	61 ,,
September	..	..	38 ,,
October	..	..	10 ,,

giving a total of 386 infected plantations, of which 49 (affecting 49 acres) were not known to be diseased last year.

The following table gives the intensity of disease in each year :—

Year.	Bad.	General.	Slight.	Few.	Total.
1909	—	5½	4	2½	12 acres.
1910	9½	65½	167¼	7¼	249½ ,,
1911	25	39½	137¼	94¾	296½ ,,
1912	92¼	114½	100	100¼	407 ,,
1913	147¾	135½	117	84¼	484 ,,

As the result of the unsatisfactory nature of the above Report, showing as it did an enormous increase in the area affected, after the carrying out for six years of the Board of Agriculture's "American Gooseberry Mildew Orders," the Kent County Council informed the Board in October that they refused to appoint for the future any local Inspector to enforce the Orders in Kent.

The Clerk to the County Council received in reply the following communication from the Assistant Secretary of the Board of Agriculture :—

"I have laid before the Board of Agriculture and Fisheries your letter of the 21st ult., in which you inform them that your Executive Committee have decided not to appoint any Inspectors, whereby your Local Authority will be without

the services of an Inspector to enforce the Orders issued under the Destructive Insects and Pests Acts. In reply, the Board desire me to make the following observations which I am to request you to be so good as to lay before the County Council at their next meeting, when the question raised by the Committee's decision is discussed.

"The Board are aware that the opinion has been expressed by a certain section among the fruit-growers that no remedy or effectual treatment for American Gooseberry Mildew is known, and that it would be better to leave each individual grower to deal with the disease in his own garden than to attempt to carry out the present methods. I am to suggest that if it is the case that your Committee have been influenced by this opinion the following observations should be considered by your Council before giving it their support.

"It is obvious that if it has been found difficult to cope with the Mildew by regular and concerted action, it will be more difficult to control the disease when the action is unsystematic and disorganized, for it is not to be supposed that occupiers of infected premises will be more active in suppressing disease when left to their own devices than when subject to the pressure of an Inspector. It is true that several Kentish growers have attempted to deal with the cases on their own plantations by various methods, but their efforts have generally been rendered of no effect by the neglect of their neighbours to adopt proper precautions at the same time; and so far as the Board are aware there has been no serious attempt on the part of the fruit-growers of Kent as a whole to free their County from the infection. The Board desire me to point out to your Council what an unfortunate contrast their County affords as compared with the fruit-growing district of Worcestershire. Disease was found to be widespread and serious in that County before it was known in Kent, and it was at one time thought that it was hopeless to save the Gooseberry growing industry there. The usual disinclination to adopt prompt measures was experienced and even organized resistance was shown to the Board's Order. The Local Authority for Worcestershire, however, conceived it to be their duty to enforce the Board's Order strictly, and legal proceedings were taken against a number of

offenders. Convictions were obtained in due course, these resulted in a readier compliance with the requirements of the Board's Order, and since that date the disease has generally decreased in Worcestershire, even in years when owing to unfavourable climatic conditions it has increased elsewhere. There is every reason to believe that soon American Gooseberry Mildew will in Worcestershire be reduced to very small dimensions, and the industry in that County freed from an expense and embarrassment which has in the past seriously hampered them in the competition with other districts, so that the acreage under gooseberrries there will be increased. The enclosed tabular statement shows the position in Worcestershire and Kent respectively. The same experience holds good in all other places where the procedure contemplated by the Board's Order is carried out, and success has been obtained in proportion to the strictness with which it is enforced. Your Committee on the other hand, have in no single case prosecuted any offenders, although several cases have been brought to their notice by Mr. Vinson and by the Board, which might properly have been made the subject of legal proceedings.

"The Board think that your Committee in deciding on the course of action which they recommend, have unwittingly taken a step that is not in the best interests of fruit growing in Kent, and if their decision is not re-considered, the industry will suffer a blow from which it will take many years to recover. In view of the unmistakeable evidence of other districts in favour of a strict compliance with the provisions of the Order, the Board are unwilling to believe that the Kent County Council will lend any countenance to the proposition that American Gooseberry Mildew is a disease, the control of which may be left to the unaided energies of fruit growers, and they trust that it will be decided to continue the administration of the Destructive Insects and Pests Acts, and to enforce its compliance with the Orders by legal proceedings where necessary.

"The matter is, moreover, of more than local interest. Many countries have imposed restrictions on the importation of plants from England, and a large and valuable trade is in danger of being injured unless the infectious diseases of

plants are controlled by proper precautions and adequate inspection. The Board are unwilling to think that your Council would intentionally jeopardize the trade of the country by neglecting to carry out their statutory duties, and I am therefore directed by the Board to invite the special consideration of your Local Authority to this aspect of the question."

AMERICAN GOOSEBERRY MILDEW.

YEAR.	KENT.		WORCESTER.	
	Number of Outbreaks.	No. of outbreaks where the fruit was reported to be attacked.	Number of Outbreaks.	No. of outbreaks where the fruit was reported to be attacked.
1909-10	435	13	220	24
1910-11	1127	29	294	10
1911-12	966	108	159	38
1912-13	1351	328	214	31
1913-14 (to 30th Sept. 1913.)	1538	370	143	35

The Kent County Council remained unconvinced by the arguments put forward by the Board as above, and persisted in their refusal to carry out any longer by their own Inspectors the American Gooseberry Mildew Orders. The last Report, presented on January 12th, 1914, by the Local Inspector, was as follows :—

"*Swanley District* :—

Since my Report in October, it has only been possible to inspect but very few plantations in this district, but where growers have applied for Licences for the removal of bushes I have taken the opportunity of inspecting a number of plantations.

The infected acreage (as far as it is known) therefore remains the same as given in my October report, viz. :—

Infected acreage	1,277 acres	=466 Plantations.
Passed as satisfactory ..	20 ,,	= 16 ,,
Leaving to be passed as satisfactory	1,257 ,,	=450

There are, however, a number of scheduled plantations in this district that have not been inspected during the past season.

Sandwich District:—

Infected acreage	476 acres	=382 Plantations.
Passed as satisfactory ..	$28\frac{3}{4}$,,	= 36 ,,
Leaving to be passed as satisfactory	$447\frac{1}{4}$,,	=346 ,,

There have been 9 acres grubbed in this district.

Growers are still applying for Licences for the removal of bushes in this district.

Maidstone District:—

Since my report in October there have been 23 cases of disease found.

Infected acreage	1,902 acres	=719 Plantations.
Passed as satisfactory ..	$378\frac{1}{2}$,,	=148 ,,
Leaving to be passed as satisfactory	$1,524\frac{1}{2}$,,	=571 ,,

There have also been about 30 acres grubbed in this district.

A great deal of my time has been occupied in inspecting nursery stock for the issuing of Licences, one case has occurred where a grower sent a consignment of bushes to Northumberland, which were slightly diseased."

On the refusal of the Kent County Council to administer the Orders, the Board of Agriculture decided to appoint a staff of "Local" Inspectors for Kent and other Counties. The American Gooseberry Orders, therefore, still remain in force in Kent, just as before, although they are no longer in any way under the control of the County Council.

Reviewing the course of events during the past year, it must be pointed out that the action of the Board in condoning the refusal of certain growers to "tip," and allowing them to substitute spraying, must inevitably make the carrying out of the Order of much greater difficulty in the future.

The absence of a decisive official plan, based on authoritative scientific advice, which has lately characterized the

proceedings, must be attributed to the fact that the Board of Agriculture, in dealing with this mildew, are still without the advice or guidance of any mycologist conversant with the practical details. There is now an official entomologist supplying such assistance in the case of the insect pests which are being dealt with by legislative measures, but there is no mycologist. With the recent discovery of new and important facts in the life history of the American Gooseberry Mildew, (see below, p. 432 and p. 439), which may be of considerable importance in the practical control of the disease, the need for an official mycologist to give advice as to the best State measures to be adopted against the mildew, becomes more and more imperative.

The results of the spraying experiments carried out last year in Kent are given below at p. 403. With the heavier infestation of plantations that is occurring annually, it is clear that an earlier appearance of the mildew than previously must be expected, especially on the berries.

This year I received examples of the "summer-stage" from a plantation in East Kent, on April 6th; and the Board of Agriculture have reported a similar case in a plantation in Cambridgeshire, on the same date.

SPRAYING EXPERIMENTS AGAINST THE AMERICAN MILDEW.

(*Sphaerotheca mors-uvae*).

By E. S. Salmon.

In previous numbers of this *Journal* I have given the results of spraying experiments against the American Gooseberry mildew, which have been carried out during past seasons either at Wye College, or on fruit farms in Kent. In the present article the spraying experiments which were carried out during 1913 on farms at three centres in Kent are described. Further, some new or little-known facts—likely to prove of practical importance—concerning the life history of the American Gooseberry-mildew are here recorded.

1.—*Spraying Experiments.*

The spraying experiments in 1913 had two main objects; firstly, to continue the work of ascertaining at what strength and to what extent lime-sulphur can be used on the various commercial varieties of Gooseberries without causing injury; and secondly, to compare the fungicidal action, against the mildew, of lime-sulphur and the "liver-of-sulphur" solution. The bushes used, situated in large commercial plantations on fruit farms at the three centres, Rodmersham, Boughton-under-Blean, and Mereworth, were freely offered by farmers for experimentation in any direction. In order to ensure thorough and uniform sprayings, the work of mixing and applying the various washes used was done by Mr. R. G. Hatton and myself, Mr. R. G. Hatton (now of the Horticultural Staff of Wye College) doing all the actual spraying, as well as assisting in making observations. It has been due to Mr. Hatton's energy and strength that a very large number of bushes were able to be sprayed experimentally. The Vermorel "Eclair étamé" knapsack sprayer was used, with a nozzle giving a very fine "misty" spray.

The sprayings will be described under the different centres and the name of the variety of Gooseberry.

CENTRE: RODMERSHAM:

PLOT I.—YELLOW ROUGH (GOLDEN DROP).

The bushes were eight years old, in a plantation shaded by mature fruit trees.

May 2nd.—(1) 6 bushes sprayed with lime-sulphur, 1.01 sp. gr.
(2) 5 „ „ „ „ 1.005 sp. gr.
(3) 25 „ „ „ iron-sulphide (Oregon formula)*

On *May 13th* no appreciable injury was visible, but there were slight indications of a leaf-fall beginning on the iron-sulphide plot; these bushes were, therefore, not sprayed again.

May 13th.—(1) As before.
(2) „
(4) 8 bushes sprayed with lime-sulphur 1.01 sp. gr.
(5) 9 „ „ „ „ „ 1.005 sp. gr.
(6) 10 „ „ „ "liver-of-sulphur" solution, 1 oz. to 3 gall. water.

On May 26th the following injury was observed:—

(1) and (2). A very severe leaf-fall had taken place, and there was a characteristic odour of decaying vegetation from the sprayed leaves still remaining on the bushes. The amount of injury done was sufficient to preclude the use of lime-sulphur. (3) The bushes showed a serious leaf-fall; from many of them came the characteristic sickly-sweet or almost pungent smell of leaves injured and slowly dying as the result of the spraying. In view of the fact that the iron-sulphide spray is stated to be quite harmless to the foliage of the apple and rose, the doubt arose whether the wash used (although made strictly according to the formula) had been washed absolutely free of lime-sulphur (see footnote). To test this point, sprayings were now made with the iron-sulphide wash, proved by chemical tests to be absolutely free from lime-sulphur (see below, *May 26th*, (9) and (10)). (4) The bushes now showed that a marked leaf-fall had been caused. (This had not taken place, it may be noted, by May 20th.) (5) The bushes showed a leaf-fall just commencing. (6) No leaf-fall had taken place, but there was a more or less distinct yellowing of the older leaves, caused by the action of the spray. Since, on the plots (1), (2), (4) and (5), the same serious injury was being caused by the lime-sulphur spray

* This wash was made on the following formula, given by Prof. P. J. O'Gara, in his leaflet, "Lime-Sulphur," (Rogue River Valley, Medford, Oregon. 1911). "Iron-sulphate. 1lb. lime-sulphur (32 degrees Beaume test) 1 quart, water 10 gallons. Dissolve the iron-sulphate in about 5 gallons of water and add the quart of lime-sulphur, stirring well. Let the black precipitate settle for a few hours and pour off the liquid, keeping the precipitate. Then add 5 gallons of water, stir thoroughly and let settle again. Pour off the liquid as before. This process is called washing, and is necessary in order to get rid of the lime-sulphur, which would burn tender foliage. Repeat the washing until the water is no longer yellow. The black 'muck' should be diluted to 10 gallons and sprayed with good agitation. . . . This is the standard [summer] spray for apple and rose mildew for this district." This spray did not spread well, though the leaves of the bushes became fairly well covered with the large blotches.

as had been observed in previous seasons, it was decided to discontinue the use of this spray.

May 26th.—(6) As before.
(7) 8 bushes sprayed with "liver-of-sulphur" solution, 1 oz. to 3 gall. water.
(8) 8 bushes sprayed with "liver-of-sulphur" solution, 2 ozs. to 3 gall. water.
(9) 8 bushes sprayed with iron-sulphide.
(10) 8 ,, ,, ,, ,, half-strength.

On *June 6th* all the sprayed bushes showed so severe a defoliation that it was useless to continue using any of the washes. The chemically tested iron sulphide (9) and (10), had produced as severe an injury as that originally used. (3) All the bushes where "liver-of-sulphur" had been used were by now equally damaged.

At this date, also, it was apparent that the sprayings had not kept off the mildew from the fruit of the bushes in many of the plots; a number of berries were severely affected, more particularly in the iron-sulphide plots.

The high degree of susceptibility which is shown by *Yellow Rough* to injury from the effects of sulphur washes became apparent under the following circumstances. A plantation of *May Duke* was sprayed with lime-sulphur; a short time afterwards it was observed that some bushes of *Yellow Rough* which adjoined the sprayed *May Dukes* although they had been untouched by the spray, had dropped a considerable number of their leaves. This injury extended to about five rows of the *Yellow Rough.* It seemed clear that in this case the gas (either sulphuretted hydrogen or sulphur dioxide) which is given off from the lime-sulphur wash when exposed to the air, was responsible for this leaf-fall. To ascertain whether this really was the case, some lime-sulphur was sprayed on to the soil surrounding some bushes of *Yellow Rough,* care being taken that none of the spray touched the bushes. After a few days a considerable leaf-fall resulted.

The Kent County Council Inspectors have informed me that "flowers of sulphur" dusted over bushes of *Yellow Rough* causes a severe defoliation.

All the experiments show clearly that it is unsafe to use sulphur in any form on *Yellow Rough,* as severe defoliation results. The same is the case when the iron-sulphide wash is used.

PLOT 2.—FREEDOM.

The bushes were eight years old, and partly shaded under fruit trees.

May 2nd.—(1) 6 bushes sprayed with lime-sulphur, 1.01 sp. gr.
(2) 6 ,, ,, ,, ,, ,, 1.005 sp. gr.

May 13th.—(1) As before.
(2) ,,
(3) 10 bushes sprayed with lime-sulphur, 1.01 sp. gr.

[*May 26th.*—(1) As before.
(2) „
(4) 8 bushes sprayed with lime-sulphur, 1.01 sp. gr.

On *June 6th* the bushes in (1) and (2) which had been sprayed three times with lime-sulphur, showed a marked leaf-fall. No leaf-fall or other injury appeared on the bushes (3) sprayed once with lime-sulphur on *May 13th;* while a slight, but not serious, leaf-fall occurred on the bushes (4) sprayed once with the same wash on *May 26th.*

It would appear that *Freedom* may safely be sprayed with lime-sulphur at "full strength" once or twice in May or earlier, but more repeated applications or spraying later in the season will cause a certain amount of leaf-fall.

PLOT 3.—HOWARD'S LANCER.

The bushes were ten years old, and situated in the open.

May 2nd.—(1) 5 bushes sprayed with lime-sulphur, 1.01 sp. gr.
May 13th.—(1) As before.
June 12th.—(1) „

No injury resulted at any time. It seems safe to conclude that *Howard's Lancer* may safely be sprayed three times successively with "full strength" lime-sulphur during May and June.

PLOT 4.—MAY DUKE.

The bushes were twelve years old, and growing in an open position.

May 13th.—(1) 11 bushes were sprayed with lime-sulphur, 1.01 sp. gr.
(2) 6 bushes „ „ „ "liver-of-sulphur" solution, 1 oz. to 3 gall. water.
May 26th.—(1) As before.
(2) „
June 6th.—(1) As before.
(2) „
June 12th.—(1) As before.
(2) „
June 23rd.—(1) As before.
(2) „

Beyond the falling of a few leaves from the bushes sprayed with "liver-of-sulphur," no injury resulted. It can be concluded, therefore, that *May Duke* may safely be sprayed five times successively, during May and June, with either lime-sulphur or "liver-of-sulphur" solution.

PLOT 5.—GUNNER'S SEEDLING.

The bushes were eight years old, and partly shaded under fruit trees.

May 2nd.—(1) 14 bushes sprayed with lime-sulphur, 1.01 sp. gr.
(2) 10 „ „ „ „ 1.005 sp. gr.

May 13*th*.—(1), (2), (3) 50 bushes (including (1) and (2)) were sprayed with lime-sulphur, 1.01 sp. gr.

(4) 11 bushes were sprayed with "liver-of-sulphur" solution, 1 oz. to 3 gall. water.

May 26*th*.—(1), (2), (3) As before (a light spraying only, to cover the new shoots).

(4) As before.

June 6*th*.—(5) 25 bushes sprayed with lime-sulphur, 1.01 sp. gr.

(6) 11 bushes sprayed with liver-of-sulphur solution, 2 oz. to 3 gall. water.

June 12*th*.—(1), (2), (3) As before.

(4) ,,

No injury whatever resulted from any of the sprayings. *Gunner's Seedling* may safely be sprayed four times successively during May and June with "full-strength" lime-sulphur.

PLOT 6.—COUSIN'S SEEDLING (*Sandwich Yellow*).

The bushes in one part of the plantation were eight years old (called "old" below), and more or less shaded under fruit trees; in the other part they were four to six years old (called "young" below), and situated in the open.

May 2*nd*.—(1) 12 "old" bushes sprayed with lime-sulphur 1.01 sp. gr.

(2) 10 ,, ,, ,, ,, ,, 1.005 sp. gr.

(3) 20 "young" ,, ,, ,, 1.01 sp. gr.

On *May* 13*th* no injury was observable.

May 13*th*.—(1), (2), (4) 50 "old" bushes (which included (1) and (2), sprayed with lime-sulphur, 1.01 sp. gr.

(3), (5) 53 "young" bushes (which included (3)), sprayed with lime-sulphur, 1.01 sp. gr.

(6) 10 "old" bushes sprayed with "liver of sulphur" solution, 1 oz. to 3 gall. water.

(7) 20 "young" bushes, sprayed with "liver of sulphur" solution, 1 oz. to 3 gall. water.

On *May* 26*th* no injury was observable on the "old" bushes; in the case of the "young" bushes sprayed with lime-sulphur (3), (5) the leaves showed a slight but distinct scorching of many of the leaves, which were brown at the tips and edges; no leaf-fall resulted and the injury done was not serious and of no practical importance. (The same scorching effect was noticeable on the adjoining part of the plantation—consisting of bushes of the same variety and age—where spraying had been done with a power sprayer, using lime-sulphur 1.01 sp. gr.).

May 26*th*.—(3), (5) As before.

(6) ,,

(7) ,,

(8) 10 "old" bushes sprayed with "liver of sulphur" solution, 1 oz. to 3 gall. water.

(9) 7 "old" bushes sprayed with "liver of sulphur" solution, 2 oz. to 3 gall. water.

June 6th.—(10) 15 "old" bushes sprayed with "liver of sulphur" solution, 2 oz. to 3 gall. water.

(11) 37 "old bushes" sprayed with lime-sulphur, 1.01 sp. gr.

June 12th.—(1), (2), (4), As before.

(3), (5) ,,

(6) ,,

(8) ,,

(9) ,,

(10) ,,

June 23rd.—(1) (2) (4) As before

(3) (5) ,,

(10) ,,

July 12th.—(1), (2), (4) As before

(3), (5) ,,

The results of the sprayings as regards injury may first be noted, and then, secondly, the effect of the sprayings in dealing with an outbreak of the mildew that occurred in this plantation. The experiments demonstrated that lime-sulphur at "full-strength" can be used with perfect safety on *Cousin's Seedling*—a variety not hitherto experimented with. Successive sprayings, repeated five times, on "old" bushes, and six times on "young" bushes, from May to July, caused no appreciable injury to the leaves or shoots. This is a fact likely to prove of considerable practical importance in the future treatments against mildew of this very valuable late dessert gooseberry. The "liver-of-sulphur" solution, at 1 oz. to 3 gall. water, caused no appreciable amount of scorching, and no leaf-fall; but the same solution at the rate of 2 ozs. to 3 gall. water, even when applied in cool weather, caused an amount of injury which clearly indicated that the danger-point was reached. As, however, the "liver-of-sulphur" solution showed itself under the conditions to be quite ineffectual in stopping the spread of the mildew, the point is of less practical importance.

On *May 26th* the outbreak of mildew first started in the plantation. On that day the mildew was found in the "powdery" summer-stage, curling the young leaves of some shoots growing from four bushes of *Cousin's Seedling*, which had been cut down to the ground in the summer of 1912, because they were at that time virulently attacked by the mildew. In one case, even at this early date—May 26th—the spawn (*mycelium*) of the mildew on the surface of one of the shoots was turning brown, *i.e.*, beginning to form the "winter-stage." On the discovery of the outbreak, the four bushes were very heavily sprayed with lime-sulphur, 1.01 sp. gr. On *June 6th* all the original patches of mildew on the four bushes were seen to be stopped or killed, and no fresh infections on these bushes were to be found. The spray had slightly scorched the tips of the young leaves, but no appreciable injury was caused. By this day (*June 6th*) the mildew had appeared on nineteen more bushes of Cousin's Seedling. On these bushes the mildew was in vigorous white powdery patches, both on the berries and on the leaves of the shoots (which were curling under the attack), and

also, it had developed in many cases the brown winter-stage both on the berries and on the surface of the shoots. The infection of these nineteen bushes had certainly taken place between *May 26th* and *June 6th*. The general condition of these infected bushes and the spray given them on *June 6th* were as follows :

Bush 5.—Severe attack ; summer- and winter-stage on tips of most shoots.

,, 6.—Slight attack, just starting ; summer-stage only on few tips.

,, 7.—Severe ; summer-stage on most tips.

,, 8.—Slight ; summer-stage on few tips.

,, 9.—Severe ; summer- and winter-stage on many tips.

,, 10.—Slight ; summer-stage just beginning.

,, 11.—Slight ; summer-stage just beginning.

Bushes 5 to 11 were given a heavy spraying (the bushes being drenched) with "liver of sulphur" solution, 2-oz. to 3 galls. water.

,, 12.—Moderate attack ; summer- and winter-stages on several shoots.

,, 13.—Slight attack ; summer-stage just beginning.

,, 14.—Slight attack ; summer-stage just beginning.

,, 15.—Severe attack ; most tips affected with big patches of summer-stage.

,, 16.—Severe attack ; most tips affected with big patches of summer-stage.

,, 17.—Slight attack ; summer-stage only.

,, 18.—Severe attack ; a little winter-stage as well as summer-stage on most of the shoots.

,, 19.—Slight attack ; summer-stage on shoots and a number of berries.

,, 20.—Slight attack ; summer-stage on shoots and a number of berries.

,, 21.—Slight attack ; summer-stage on shoots only.

,, 22.—Slight attack ; summer-stage on shoots only.

,, 23.—Slight attack ; summer-stage on shoots only.

On *June 12th* the seven bushes (Nos. 5 to 11) which had been sprayed heavily on *June 6th* with "liver of sulphur" solution were examined, and it was found that *the spread of the mildew had not been checked on them*,—the disease being quite as bad or even worse, with numerous white, powdery patches of the summer-stage, and extended patches of the brown winter-stage. The twelve bushes (Nos. 12 to 23) which had been sprayed with lime-sulphur, were in a much healthier condition ; there were now no powdery patches of the summer-stage, though patches of the winter-stage were still to be seen, and it was clear that the spread of the disease was greatly checked. At this date the seven bushes (Nos. 5 to 11) were again sprayed with the "liver of sulphur" solution ; the lime-sulphured bushes (Nos. 12 to 23), being still well covered, did not at this time receive another spraying.

On *June 23rd* another examination was made of the mildewed bushes in this plantation. Taking first the four bushes which had

been cut down in 1912, the shoots from these had by now produced about six inches of fresh growth; in most cases these had become attacked by mildew. The condition of the bushes was as follows: bush (1), a good deal of summer-stage on the young shoots; (2) and (3), tips badly infested with both the white "summer-stage" and the brown "winter-stage"; (4) no fresh infections. These bushes were now sprayed again with lime-sulphur.

With regard to the bushes sprayed with the "liver of sulphur" solution, their condition was as follows:

Bush 5.—*A mass of disease;* the spawn (*mycelium*) had developed extensively, and now covered the tips of the greater number of the shoots with continuous brown patches, half inch to three inches long; the fruit, too, was much attacked, about 75 per cent. of the berries being more or less completely enveloped in the brown winter-stage.

Bush 6.—Mildew still present in both summer- and winter-stages on the tips of most shoots.

Bush 7 and 8.—Tips of shoots with abundant powdery summer-stage,—disease in very infectious stage and obviously on the increase.

Bush 9.—Disease severe; on shoots and berries in summer- and winter-stages.

Bush 10 and 11.—Most of the tips of the shoots smothered with the summer-stage, and about 50 per cent. of the berries with large patches of the winter-stage.

It was perfectly clear that under the conditions prevailing the "liver of sulphur" solution was powerless to check in any way the spread of the mildew. The facts are as follows: The bushes had been kept under careful observation through May and June, and it is certain that no mildew was present until *June 6th*, when a very few spots of the white summer-stage were found. All the bushes were immediately drenched with "liver of sulphur" solution at the strength of two ounces to three gallons of water,—which was clearly the strongest solution possible, since at this strength the tips of the youngest shoots were turned brown and killed, and also the edges of the young leaves were scorched and shrivelled up. Another similar drenching with the same wash was given on *June 12th*, less than a week after; yet the disease was not appreciably checked in any way, many of the bushes on *June 23rd* being literally smothered with disease on shoots and berries. In the case of some of the bushes, notably bushes 5, 10 and 11, the fact that all or nearly all the berries on the lower branches became so rapidly and severely attacked strongly suggests that at the time infections were occurring plentifully from "winter-spores" (*ascospores*) arising from fruit-bodies (*perithecia*) which had wintered over, on or in the soil under or round the bushes.

The bushes which had received lime-sulphur were found to be in the following condition:—

Bush 12.—Small patches of the winter-stage on a few shoots (probably at the places where it existed at the time of spraying); two tips with powdery summer-stage; disease not severe.

Bush 13.—A trace only of mildew on a very few tips.

Bush 14.—A few tips with the mildew in the summer- and winter-stages; a good number (about 25 per cent.) of the berries more or less completely enveloped in the brown winter-stage. *In many cases these berries had been well sprayed with the lime-sulphur, yet they had become more or less covered with the winter-stage. The spawn (mycelium) of the winter-stage of the mildew could be seen growing and extending over the "blotches" or spots of the dried lime-sulphur.*

Bush 15, 16, and 17.—From 10 to 25 per cent. of the berries affected with the winter-stage; only a few tips showing the mildew (in summer-stage).

Bush 18.—Tips of shoots free from mildew; a little winter-stage on a few berries.

Bush 19.—Two tips apparently just infected,—white and powdery.

Bush 20.—Shoots all healthy.

Bush 21.—A mere trace of the disease.

Bush 22.—Many (about 40 per cent.) of the berries and also of the shoots with patches of the winter-stage; a few tips showing the summer-stage.

Bush 23.—Fresh infections on many of the tips; patches of the winter stage on the older parts of several shoots.

Although these bushes, which had been sprayed once with lime-sulphur, had certainly considerably less mildew on them than those bushes (Nos. 5 to 11) which had been sprayed twice with the "liver of sulphur" solution, it was clear that the lime-sulphur wash had had no deterrent effect on the growth of the *mycelium* of the winter-stage. Further, either the spraying on *June 6th* had not killed all the summer-stage present, or, more probably, the young growth of the bushes had become re-infected by *air-borne spores* in the interval between *June 6th* and *June 23rd.* As in the case of the bushes, noted above, there were indications, *e.g.*, with respect to bushes 14, 15, 16, 17 and 22, that the berries had all been heavily infected about the same time, very possibly from winter-spores (*ascospores*) arising from the soil; in which case spraying would be of little or no use.

It may be noted, further, that the fifteen bushes (see p. 408 (10), which had been sprayed heavily with "liver-of-sulphur" solution on *June 6th, June 12th*, and *June 23rd*, were on *July 12th* smothered with mildew at the ends of the shoots.

In 1912 many of these bushes of *Cousin's Seedling* suffered from a severe attack of mildew, and the berries became very badly diseased. The diseased berries were not removed until August, when the crop was ripe, by which time it is probable that considerable numbers of fruit-bodies (*perithecia*) had fallen to the ground (see below, p. 424). The sudden and severe attack on the berries in 1913 (noted above) may perhaps be attributable to winter-spores arising from the ground in June, 1913, in consequence of the infestation of the soil in August, 1912.

Cousin's Seedling appears to be specially liable to severe attacks of the mildew, both on the shoots and on the berries. Owing to its habit of growth, *viz.*, the horizontal branches keeping low near the ground, the bush is difficult to spray, unless specially pruned to encourage an upward growth of the branches. In view of the great damage done by the mildew to this variety, such a system of pruning should always be adopted. When the berries are attacked early, *the entire crop may be destroyed.* The young berries often become completely infested all round with the brown scurf-like spawn (*mycelium*) and so are prevented from growing out (see photograph of the upper berries in Plate 1).

In a one-acre plantation of *Cousin's Seedling* in East Kent, which I visited last August, there was scarcely one berry to be found which was not diseased; the great majority of the berries over the whole plantation had been prevented by the mildew from growing to more than a quarter of their proper size (see Plate I.). Not a berry was picked for market off the whole piece. It is extremely important, for the reason given below (p. 424) that all diseased berries of *Cousin's Seedling* and other late varieties, are picked and destroyed before the mildew has developed the brown winter-stage on them.

PLOT 7.—BERRY'S EARLY.—The bushes were about ten years old, and shaded under mature fruit-trees.

May 13th.—(1) Six bushes sprayed with lime-sulphur, 1.01 sp. gr.
(2) Six bushes sprayed with lime-sulphur, 1.005 sp. gr.
(3) Eight bushes sprayed with "liver-of-sulphur" solution, 1 oz. to 3 gallons of water.

May 26th. (1) As before.
(2) ,,
(3) ,,
(4) Ten bushes sprayed with lime-sulphur, 1.01 sp. gr.
(5) Seven bushes sprayed with lime-sulphur, 1.005 sp. gr.
(6) Ten bushes sprayed with "liver-of-sulphur" solution, 1 oz. to 3 gallons water.
(7) Ten bushes sprayed with "liver-of-sulphur" solution, 2 ozs. to 3 gallons water.
(8) Seven bushes sprayed with iron-sulphide, "half-strength."

June 12th.—(1) As before.
(2) ,,
(3) ,,
(4) ,,
(5) ,,
(6) ,,
(7) ,,
(9) Four bushes sprayed with "liver-of-sulphur" solution, 1 oz. to 3 gallons water.
(10) Four bushes sprayed with "liver-of-sulphur" solution, 2 ozs. to 3 gallons water.

June 23rd.—(1) As before.
(2) ,,
(9) ,,
(10) ,,
July 12th.—(1) ,,
(2) ,,
July 28th.—(1) ,,
(2) ,,

No injury resulted in any case, even on the bushes (1) and (2), which received six thorough sprayings with lime-sulphur.

The effect of the spraying on the mildew may now be noted. By July 12th a severe attack of mildew was in evidence in the plantation (of about $1\frac{1}{2}$ acres) of Berry's Early in which Plot 7 was situated. The mildew occurred in its summer- and winter-stages practically all over the plantation, being particularly bad on the bushes adjoining the sprayed plot, some of which had practically every tip badly attacked. An examination of the sprayed bushes at this date gave the following results :—

(1) The eight bushes which had been sprayed four times with "full strength" lime-sulphur were quite free from mildew.

(2) The ten bushes sprayed four times with "half-strength" lime-sulphur showed the mildew just appearing on the tips of several shoots.

(4) and (5) These bushes sprayed twice with lime-sulphur (last spraying June 12th), were just beginning to be attacked at the tips.

(3) These bushes sprayed three times with "liver-of-sulphur" solution were very badly infected for a considerable length at the ends of most of the shoots.

(6) The ten bushes sprayed twice with the "liver-of-sulphur" solution were now all badly infected on most of the shoots.

(7) The ten bushes sprayed with the stronger solution of "liver-of-sulphur" were similarly affected.

(8) The bushes were all badly infected.

(9) and (10) The two sprayings with "liver-of-sulphur" solution on *June 12th* and *June 25th* had not protected the bushes from infection, most of the tips now showing the disease in a virulent and infectious condition.

The first interesting point was the superiority shown (as in the case of Plot 6 of *Cousin's Seedling*, p. 409), by lime-sulphur in keeping off the mildew in comparison with the "liver-of-sulphur" solutions. The second point of interest was the sudden appearance of the mildew in such virulence over so large an area ; on June 23rd there was no sign of the mildew over the whole plantation of *Berry's Early*, by *July 12th* the mildew was general over the whole piece with the exception of plots (1), (2), (4), and (5), not only in the summer-stage, but it was equally plentiful in the winter-stage. There was every indication of the

bushes having been generally infected by a profusion of "summer-spores" carried on the wind into the plantation. Could this have been anticipated, a thorough spraying with lime-sulphur on some date between June 23rd and July 12th, would have saved this particular plantation, if not entirely from the disease, at any rate from the severity of the infestation.

As the bushes (1) and (2) were, owing to the previous lime-sulphur sprayings, free or almost free from the mildew, these were sprayed again on July 12th. On July 28th the bushes in (1) and (2), which had been sprayed respectively, with lime-sulphur at "full" and "half-strength," showed traces of the mildew on the young freshly

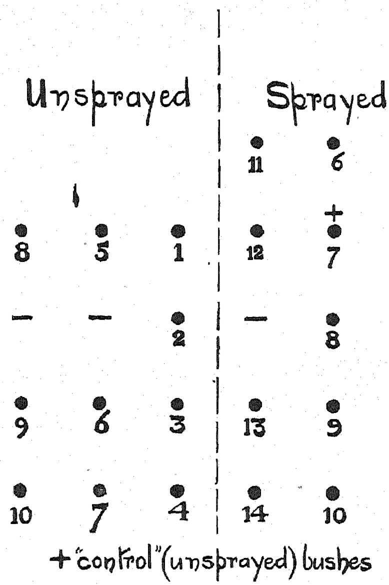

FIG 1.
Plan of sprayed and unsprayed bushes.

grown-out tips of several of the shoots. This amount of infection was practically inevitable, in view of the fact that the adjacent bushes (to which nothing was done) stood smothered with mildew in its powdery, infectious summer-stage, from July 12th onwards, so that "spores" must have been continually blown on to the sprayed bushes. Although it was known from previous observations that the spraying would not prevent the mildew already present from forming its winter-stage, lime-sulphur was applied to (1) and (2), as before, for the sixth time.

On November 24th, the final examination of the lime-sulphured bushes was made. A plan is given at Fig. 1 of the position of the bushes

(1) and (2), of the two "controls," and of the ten adjoining unsprayed bushes which were examined for comparison. These bushes were gone over in the following manner; all the shoots that showed any of the disease* were cut off, and then separated into two classes, as follows: Class 1, with more than one inch of continuously diseased shoot; Class 2, with less than one inch of continuously diseased shoot. The examination gave the following results:

SPRAYED BUSHES (1), (2) and "CONTROLS."

No. of bush in plan.	No. of shoots with *over* 1 inch continuously diseased.	No. of shoots with *under* 1 inch continously diseased.	Total No. of diseased shoots.
1	1	3	4
2 *Control*	23	37	60
3	4	14	18
4	3	7	10
5	7	11	18
6	9	7	16
7 *Control*	49	42	91
8	15	9	24
9	14	19	33
10	8	4	12
11	1	9	10
12	1	5	6
13	32	17	49
14	5	5	10

These figures show that the spraying had a considerable effect against the mildew. Taking the averages, we find that the average number of diseased shoots per bush on the twelve sprayed bushes was eighteen; while for the unsprayed "control" bushes it was seventy-five.

The good that was done by spraying is seen even more clearly by comparing the amount of disease on the bushes of the three sprayed rows with the bushes (of the same age and size) of the three adjacent unsprayed rows. The examination of these unsprayed bushes gave the following results.

* The mildew was now all in the dark brown "felted" winter-stage.

UNSPRAYED BUSHES.

No. of bush in plan.	No. of shoots with *over* 1 inch continuously diseased.	No. of shoots with *under* 1 inch continuously diseased.	Total No. of diseased shoots.
1*	18	9	27
2	73	33	106
3	33	32	65
4	27	41	68
5	102	56	158
6	89	45	134
7	85	31	116
8	140	28	168
9	120	43	163
10	112	42	154

These figures show that the average number of diseased shoots per bush was no less than 116, of which eighty had more than one inch of continuously diseased shoot. In the case of the sprayed bushes, the average number of diseased shoots per bush was 17.5, of which 8.3 had more than one inch of continuously diseased shoot. Converting the figures as to the intensity of the disease to percentages, we have in the case of the sprayed bushes 100 shoots with over one inch continuously diseased in the 210 affected shoots, *i.e.*, 47.6 per cent., while for the unsprayed bushes the figures are 799 shoots with over one inch continuously diseased in the 1,159 affected shoots, *i.e.*, 68.9 per cent. The length of the diseased portion of the shoots that has to be removed in "tipping" is of course a point of considerable practical importance as the removal of many inches means (unless the bush is "spur" pruned) the removal of a considerable part of subsequent crops.

A point of possibly considerable practical importance may be noted here. On *July 28th* one of the bushes of *Berry's Early* in the plantation noted above, which was so badly attacked by mildew, was "tipped." The bush, which stood to the left of the "unsprayed" bushes shown in the plan on p. 414, was quite as badly affected as any of these, the tip of nearly every shoot bearing extended patches of mildew in the brown winter-stage, so that considerably over a hundred shoots had to be "tipped." On inspecting this bush in November, it was found that no fresh growth of the bush had been caused by this "tipping," and

* This was a very small bush; it had mildew on every shoot.

that in its absence there had been no fresh infection by the mildew of the bush, which now stood perfectly healthy. With large bushes of this age, then, in such a season as the past, the winter-stage of the mildew can be safely removed as early as *July 28th.*

The plantation ($1\frac{1}{2}$ acres) of Berry's Early was sprayed (with the exception of the bushes of Plot 7) by the farmer, as follows. On May 2nd half-an-acre was lightly sprayed with lime-sulphur at "half-strength" (1.005 sp. gr.). No injury resulted. The crop was picked on June 9th and June 10th; no sediment was then noticeable on the berries in the sprayed part. A trace of mildew was found on a very few berries,—equally in the sprayed and unsprayed parts of the plantation; very probably this early infection of the berries (no mildew occurred on the shoots at this date) was caused by winter-spores arising from the ground. On June 11th the whole plantation was sprayed with lime-sulphur, 1.005 sp. gr. No injury resulted. At the beginning of July, the plantation, for the greater part, became virulently infected, probably by air-borne summer-spores; in many cases over one hundred shoots on one bush showed badly-diseased tips (see above, p. 415). It is very doubtful if the two sprayings of lime-sulphur which were given this plantation at the dates mentioned above were of any practical use.

The weather conditions at the times of spraying at the Rodmersham centre, and the dates of the appearance of mildew in various parts of the plantation, were as follows:

May 2nd.—Bright sunshine, but not hot; showers of rain in early part of day; at the time of spraying there was no sunshine, and on most bushes a leaf here and there was still wet with rain. No mildew to be seen.

May 13th.—Cloudless sky; bright continuous sunshine, hot at times but tempered by breeze. The mildew in the summer-stage found on two bushes of *Cousin's Seedling*, in part of plantation adjoining the experimental plots. The mildewed bushes and the surrounding ones were well sprayed with lime-sulphur (1.005 sp. gr.) by the farmer on *May* 14th.

May 26th.—Continuous hot sunshine; little breeze. Mildew in very powdery and infectious summer-stage attacking virulently the shoots growing from four bushes of *Cousin's Seedling* which had been cut down for mildew in 1912. On one of the stems the spawn (*mycelium*) of the mildew was turning brown, and already beginning to form the winter-stage.

June 6th.—Bright sunshine; coolish breeze. The mildew in summer- and winter-stages appearing on the shoots and berries of unsprayed *Gunner's Seedling*; also on the berries (towards the centre of the bush) of two bushes of the same variety which had been twice sprayed with "liver-of-sulphur" on *May 13th* and *May 26th*. Mildew also present on shoots and berries of many of the sprayed bushes of *Yellow Rough*, and on unsprayed bushes of *Freedom*.

June 12th.—Sky overcast; very close,—after storm; no bright sunshine.

June 23rd.—Clear sky ; hot sunshine.

July 12th.—Bright, sunny intervals between heavy showers; close.

CENTRE: MEREWORTH.

PLOT I.—LANCASHIRE LAD.

The bushes were about ten years old, in a plantation shaded by fruit trees.

Before the experiments started, all the bushes had been sprayed six times by the farmer, the first three times with lime-sulphur, and then three times with "liver-of-sulphur" solution.

June 2nd.—(1) Fifty bushes sprayed with lime-sulphur, 1.01 sp. gr.
(2) Twenty-five bushes sprayed with "liver-of-sulphur" solution, 2 ozs. to 3 gallons water.

June 9th.—(2) As before.

June 21st.—(1) As before (a light spraying to cover the fresh growth).
(2) ,,

July 14th.—(1) ,,
(2) ,,

No injury resulted from the three applications of lime-sulphur, nor any serious injury from the four applications of the "liver-of-sulphur" solution. On *June 21st* a slight leaf-fall, somewhat sporadic, and nowhere to any serious extent, occurred on the bushes sprayed with "liver-of-sulphur" solution.

On visiting the farm on *June 2nd*, the mildew in its summer-stage was seen on a few berries, but after a careful search through all the plantations no mildew could be found on the leaves or shoots. The mildew was first seen on the shoots on *June 9th*, but owing to the hot, dry weather which followed, causing a "ripening" of the shoots, no serious spread of the mildew occurred during June.

On June 21st a trace of mildew was first observable in the sprayed plot, viz., on the shoots of many of the bushes which had been sprayed with "liver-of-sulphur," while no mildew was present on the lime-sulphured bushes. (On the bushes in another part of the plantation, which had not been sprayed since May, the mildew was thick on the young shoots of many of the bushes.) The weather conditions from about *June 10th* to *June 20th* were not favourable to the spread of the mildew; and on *July 14th* there was still no mildew on the lime-sulphured bushes, and less mildew on those sprayed with "liver-of-sulphur" than there had been on June 21st.

The berries, which were now ripe, were quite free from mildew; those on the lime-sulphured bushes were so marked by the spray that they could not have been marketed without treatment. Some of the worst affected ripe berries of these *Lancashire Lads*, together with some equally ripe and marked berries from the lime-sulphured *May Duke* bushes (see above, PLOT 4), were passed through Fletcher & Becker's "Gooseberry Cleaner" machine. By means of its ingenious arrangement of brushes, this machine removed the wash satisfactorily from

the sides of the berries, without bruising them, and so made the sample quite bright and of normal appearance; traces of the wash could still be seen on close inspection at the eye and round the stalk, or where a wrinkle occurred in the skin, but such minute spots would not, of course, affect the market value.

The weather conditions at the times of spraying at the Mereworth centre, and the dates of the appearance of mildew were as follows:—

June 2nd.—Hot sunshine; slight breeze. The mildew was found in its summer-stage on a few berries, but a careful search failed to show any shoots affected at this date. The plantation in which the mildew was found had already been sprayed six times, the first three times with lime-sulphur, and the last three times with "liver-of-sulphur" solution.

June 9th.—Cloudy at times, alternating with bright sunshine tempered by cool wind. The mildew was now seen on the shoots.

June 21st.—Sky overcast, after storm; close, no hot sunshine. No spread of the mildew to any appreciable extent had taken place; the hot weather about this time caused a ripening of the young shoots which was unfavourable to the spread of the disease.

July 14th.—Sky overcast; sultry; rain in afternoon.

CENTRE: BOUGHTON-UNDER-BLEAN.

PLOT 1.—COUSIN'S SEEDLING.

The bushes were six to ten years old, in a plantation situated in the open.

May 15th.—(1) Twenty bushes sprayed with lime-sulphur, 1.01 sp. gr.
(2) Twenty bushes sprayed with lime-sulphur, 1.01 sp. gr., plus arsenate of lead* (at rate of 2 lbs. Swift's Arsenate of Lead Paste to 50 gallons).
(3) Sixteen bushes sprayed with "liver-of-sulphur," 1 oz. to 3 gallons water.

May 30th.—(1) As before (light spraying only, to cover the fresh growth).
(2) As before (light spraying only, to cover the fresh growth).
(3) As before (light spraying only, to cover the fresh growth).
(4) Eight bushes sprayed with lime-sulphur, *plus* arsenate of lead (as before).
(5) Three bushes sprayed with lime-sulphur, 1.01 sp. gr.

June 13th.—(1) As before.
(2) ,,
(3) ,,
(6) Fifteen bushes sprayed with lime-sulphur *plus* arsenate of lead (as before).

* The addition of arsenate of lead to lime-sulphur has been stated by experimenters in the United States to add considerably to the fungicidal property of the latter. Owing to the poisonous nature of arsenate of lead, such a mixture must not be used on fruit within at least six weeks of the time of picking.

June 26th.—(1) As before.

(2) Sprayed with lime-sulphur, 1.01 sp. gr. only.

(3) As before.

(4), (5), (6) sprayed with lime-sulphur, only, 1.01 sp. gr.

(7) Twenty-one bushes sprayed with lime-sulphur, 1.01 sp. gr.

July 8th.—(1) to (7) As before.

July 30th.—(1), (2) and (3) As before.

The mildew had been noticed somewhere in the plantation by the Kent County Council Inspector, during the first week in May. The first appearance of the mildew was noticed by us on May 30th, when it was found just beginning to develop on several of the berries and on one leaf of eleven bushes which had not previously been sprayed. Eight of these bushes were at once sprayed with lime-sulphur, mixed with arsenate of lead (see above, *May 30th,* (4)), and the three remaining bushes with lime-sulphur alone (5). On *June 13th* the mildew was checked on these eleven bushes. At that date, fifteen more bushes (not hitherto sprayed) were found attacked by mildew, and on some of the bushes the attack was severe, many of the shoots being quite white and powdery with the summer-stage. These fifteen bushes were sprayed with lime-sulphur mixed with arsenate of lead (see above, June 13th (6)). About June 26*th* the mildew had appeared on twenty-one " control " bushes, which showed the tips of the shoots here and there affected with both summer- and winter-stages. These were sprayed with lime-sulphur, 1.01 sp. gr. (see June 26th (7)). The spread of the mildew became checked by a spell of hot, dry weather, which caused the shoots to turn somewhat red and ripen off. The forty bushes in (1) and (2) showed no mildew on them; the tips of the shoots, which had now grown out, were lightly sprayed over again; the sixteen bushes in (3) showed a slight trace of mildew on two of them; the twenty-six bushes in (4), (5) and (6) showed no living mildew on them, but this fact may have been due to the unfavourable weather conditions; the bushes in (7) showed only the patches of winter-stage still remaining. On July 8th there was no mildew in the spreading infectious summer-stage on any of the plots. On July 30th a trace of mildew in the summer-stage was present on the bushes which had received the " liver-of-sulphur " solution (3); very little fresh growth had been made by any of the bushes. At this date the berries were picked from the bushes (1) (2) which had received five successive sprayings with lime-sulphur—the last application having been on July 8th. The berries were a good deal marked by the wash as the bushes had been heavily sprayed; the handling of the berries in picking them, however, removed a considerable amount of the deposit. Before being sent to market they were just rinsed in water; no complaint was received from the salesman.

As at the Rodmersham centre, no injury whatever resulted from the six successive applications of " full-strength " lime-sulphur.

The weather conditions at the times of spraying at the Boughton-under-Blean centre, and the dates of the appearance of the mildew were as follows :

May 15th.—Cloudy ; no sunshine all day ; cold N. wind.

May 30th.—Hot sunshine ; sultry except for a warm wind blowing. The mildew found on several berries, and on one leaf, of eight unsprayed bushes.

June 13th.—Overcast sky ; close. The mildew occurred on fifteen more unsprayed bushes, and some of their shoots were virulently affected with the summer-stage.

June 26th.—Hot sunshine ; close. The remaining twenty-one "control" (unsprayed) bushes were now all attacked by mildew, in both the summer-stage and also (on a number of the shoots) in the winter-stage as well. These bushes were certainly attacked at some date since *June 13th,* and the mildew had developed fully its winter-stage by *June 26th.* About this date the shoots of the bushes generally began to redden and ripen, as the result of the hot weather, and this had the effect of stopping the spread of the mildew.

July 8th.—Bright sunshine, not very hot.

July 30th.—Sky overcast ; no sunshine ; cool.

The experiments carried out in the United States have indicated that the sprays containing sulphur are more efficacious in stopping the spread of American Gooseberry mildew in the summer stage than those containing copper. In America the "liver of sulphur" solution, at the strength of one ounce to two gallons of water, with about seven applications at intervals of ten to twelve days, is generally recommended as the best fungicide. It is quite clear, however, that in this country this spray, even when of greater strength and applied at shorter intervals, is powerless to check the spread of the mildew in severe outbreaks, and the lime-sulphur wash has given decidedly better results. Lime-sulphur, too, has the great practical advantage over the "liver of sulphur" wash, and over "flowers of sulphur," that it is, when once dry on the bush, so remarkably adherent that even heavy rains do not wash it off. It is very probable that "flowers of sulphur" would prove as efficacious in the summer in checking the spread of the American Gooseberry mildew as it has proved against the very closely allied Hop mildew (*Sphaerotheca Humuli*). It must be remembered, however, that "flowers of sulphur" is efficacious in dealing with the Hop mildew apparently only in periods of sunshine and high temperature, and also that rain removes it at once.

It is obvious, therefore, that "flowers of sulphur" is very unsuitable for use in spring, when frequently there are long periods of low temperature and showers nearly every day. It is intended, however, to experiment next season with "flowers of sulphur" to ascertain if this will keep off the mildew in summer from the crop of late dessert varieties of gooseberries. It may be pointed out here that the recommendation frequently given in the horticultural press to use a mixture of slaked lime and sulphur cannot be supported on either chemical or biological grounds. Slaked lime and sulphur, when mixed at the ordinary temperatures do not interact chemically, so that the addition of such lime to sulphur will only mean the application of a smaller quantity of sulphur. Recent experiments have shown that the fungicidal action of lime and sulphur is very considerably less than that of sulphur alone. Where the two were tried against Hop-mildew, the following results were obtained :—

	HOPS.					
	Free from mildew.		Slightly affected.		So badly affected as to be valueless.	
	Number.	%	Number.	%	Number.	%
Sulphur	1296	61.2	610	28.8	213	10.0
Lime and Sulphur ..	535	12.3	1273	29.4	2530	58.3

The author of the *Bulletin** remarks : "The above results are of some interest in connection with the theory of the action of sulphur. A considerable amount of work has been done which seems to indicate that the action of sulphur is due to the gradual oxidation of the sulphur, forming sulphurous acid in the presence of water, which in turn is oxidised to sulphuric acid. These acids in dilute solutions have been shown to destroy the mildew. In the presence of lime these acids would naturally unite with the lime, forming compounds quite insoluble and presumably quite harmless to the parasite."

* Bulletin 328, Cornell University, Agric. Exper. Station (1913).

Owing to the remarkably adhesive properties of lime-sulphur, the fruit of sprayed bushes becomes much marked by the dried wash. The degree of disfigurement of the crop varies a good deal according to the nature of the berry in the different varieties. In one case where some bushes of *Gunner's Seedling* and *Cousin's Seedling* were sprayed lightly with "half-strength" lime-sulphur on June 17th, the berries, when ripe on July 28th, showed a noticeable amount of deposit, particularly in the case of the *Gunner's*. The marks in this case, however, were rubbed off to a considerable extent in the process of picking, and the berries were marketed without treatment, and no complaints were received. In another case, berries of *Cousin's Seedling* were picked for market on July 30th, from bushes which had been heavily sprayed with lime-sulphur at "full strength" on July 8th. Although the berries when on the bushes were much marked with the whitish sediment of the wash, the handling of them in the operation of picking removed a good deal of it. These berries were then just rinsed in water, and marketed, and no complaints were received. With other varieties, however, *e.g.*, with Lancashire Lad, it is more difficult to clean the berries. In such cases either repeated rinsings in water must be given or the crop passed through the lately-invented Fletcher and Becker "Gooseberry Cleaner." One type of this machine grades the berries as well as cleans them; on farms where there is a large acreage of gooseberries, or in a district where co-operative marketing has been organized, the better prices obtained through the grading would in all probability justify commercially the adoption of this machine.

It may be well to point out here that there is no danger to the public health in the marketing of berries sprayed with lime-sulphur. Sulphur is not a poison, and in the very small quantities present on such berries could not possibly cause any disagreeable effects. Some berries of *Howard's Lancer* so heavily sprayed with lime-sulphur as, when dry, to be covered continuously all over with the whitish deposit, were boiled with sugar as in the ordinary domestic cookery; no objectionable smell was given off during the cooking, and the berries when eaten had no objectionable taste or unpleasant after-effects.

II.—*Observations on the Life-history of the American Gooseberry Mildew.*

Some new scientific facts of practical importance were noted at the beginning of last August in a plantation where the crop was badly affected. On examining the berries it was found that the ripe fruit-bodies (*perithecia*) had become free from the threads (*hyphae*) of the brown scurf-like spawn (*mycelium*) investing the diseased fruit, and now fell readily to the ground. On a mildewed berry being gently tapped over a piece of white paper, hundreds of just visible black "specks" could be observed on it; these put under the microscope were found to be ripe fruit-bodies (*perithecia*) containing mature winter-spores (*ascospores*). Experiments showed that such ripe perithecia, when kept supplied with moisture for a few days, and at ordinary room temperatures, open by a slit in the wall, and the contained sac (*ascus*) with its winter spores (*ascospores*) swells and protrudes (see Fig. 2). In a short time the wall of the *ascus* breaks at the apex, and the *ascospores* are forcibly discharged. It is very probable that with suitable weather conditions this discharge of winter-spores takes place in mid-summer in the plantation; if so, such winter-spores will serve to spread the disease the same season that they are produced.* It is probable, too, that many of the fruit-bodies (*perithecia*) that fall to the ground from the diseased berries will remain dormant in or on the soil until the following spring, when they will cause new outbreaks of disease.

With these fresh facts to hand, it becomes a matter of great practical importance in fighting the mildew not to allow berries with any brown winter-stage on them to remain on the bush, as there will always be the serious danger of the soil under the bushes becoming heavily infested with winter-spores (*ascospores*),—in which case spraying the next season would probably be of little avail in keeping off the mildew from the berries (see above, p. 411). To some extent, also, the fruit-bodies (*perithecia*) begin to drop in August from the patches of mildew in the winter-stage which have been formed

* I have proved that this can take place in the case of the allied mildew, *Erysiphe Graminis*, on corn and grasses.

on the shoots. As to how far this dropping to the ground of the fruit bodies (*perithecia*) in summer is exceptional or not,—whether, *e.g.*, it occurs only when the winter-stage has been formed very early in the season, or whether it is dependent on some special weather conditions at a stage in the development of the mildew,—are points to be ascertained by future

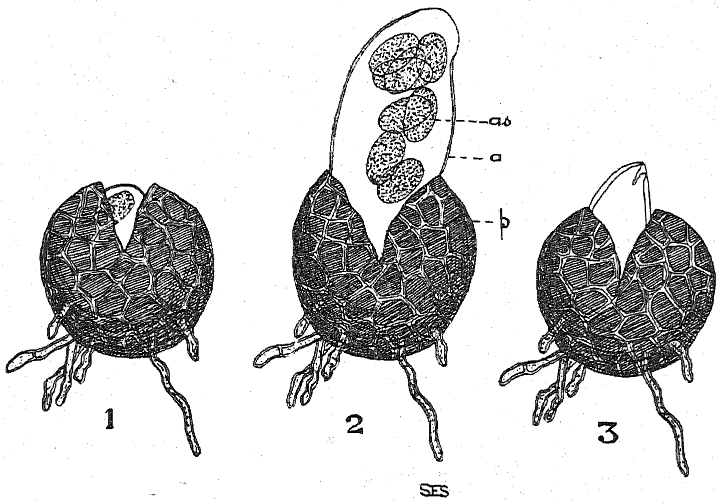

Fig. 2.

Three stages in the dehiscence of the *perithecium* of he American Gooseberry-Mildew.

p=*perithecium* ; *a*=*ascus* ; *as*=ascospores.

(Highly magnified.)

1. The perithecium splits open by a crack at the apex ; the enclosed ascus begins to swell and protrude through the opening.
2. The stage reached in about five minutes. The ascus has swollen enormously, and in consequence its wall is in a state of great tension. After a short time, as the result of increased tension, the wall of the ascus bursts near the apex, where the wall is thinner, and the eight ascospores are expelled forcibly into the air to a distance of about one inch.
3. Directly the ascospores are shot out, the empty ascus, now reduced in size, shrinks back into the perithecium.

investigations. It is certain, however, that during the past season there was an infestation of the ground taking place in August in many plantations in Kent, where late dessert varieties of gooseberries are grown.

Another fact of considerable practical importance was the very frequent occurrence during the past season of the winter-stage of the mildew *on the leaf* of the gooseberry. In cases where the shoot was severely attacked, the young leaves were arrested in growth and became ultimately continuously covered over with the brown winter stage of the fungus (see photograph in Plate II.). Shoots with the leaves affected in this way could be found by the hundred during August in badly affected plantations in many parts of Kent. In other cases, of equally common occurrence, the leaf itself was not affected in size or shape, and the infestation was confined to the lower part of the leaf stalk, where a small brown patch of the winter-stage occurred. In both cases, if such diseased leaves are allowed to fall to the ground, they cause inevitably an infestation of the soil, with the result that next spring the winter-spores rising from the ground, give rise to fresh outbreaks of mildew. To prevent this infestation of the soil it is desirable to "tip" in August before the leaves fall.

Another point in the life-history of the mildew, not sufficiently recognized hitherto, is the fact that the winter-stage may be developed almost at the very beginning of an attack. This is a fact of great practical importance, and one that makes the control of the mildew by spraying alone practically impossible. Two cases, out of many observed during 1913, may be noted here in detail. On *May 26th* some bushes of *Cousin's Seedling* which were under observation showed no mildew; on *June 6th*, these bushes, nineteen in number, were all infested with mildew, and on three of these bushes the winter-stage was already well-developed. In this case, then, inoculation and the incubation period and the development of the winter-stage had all taken place in not more than eleven days. Again, on *June 13th*, some bushes of *Cousin's Seedling*, which had been kept under observation on another farm, were quite free from mildew; on *June 26th*, all these bushes (twenty-one in number) had mildew on them, in both the winter and summer-stages; here the period was thirteen days. The fact, too, of the appearance of the winter-stage sometimes very early in the season undoubtedly

makes the work of combating the mildew more difficult. As noted above, the winter-stage was found in a plantation of *Cousin's Seedling* in Kent last season as early as *May 26th*, and by *June 6th* it was found in a mature condition on numerous [bushes of several varieties. In 1912 in Kent the winter-stage with ripe winter-spores was found on *July 17th* on both the leaves and shoots of the Red Currant.

With the fact of the almost simultaneous appearance of the summer- and winter-stages at all times of the season, it is quite obvious, since, on the one hand it is commercially impossible to keep all the shoots of the buds continuously sprayed throughout the growing period, and, on the other hand, that no spraying with lime-sulphur or any other known spray will kill the winter-stage, that some amount of "tipping" to remove the winter-stage will always be absolutely necessary. As I have pointed out below, early "tipping" must be looked upon as a measure of primary importance, and spraying at certain times only as a valuable adjunct.

III.—*General Remarks and Conclusions.*

It will probably be conceded now that the American Gooseberry-mildew has "come to stay" in this country, and that to some extent new methods of cultivation will be necessary in order to place the growing of Gooseberries on a safe commercial footing. Where Gooseberries are being grown under the shade of trees, so closely crowded that no spraying can be done, they are so "housed in" that the lack of ventilation and the delayed drying of the bushes and soil after rain, mists or heavy dews, cause outbreaks of the mildew to assume at once epidemic proportions and all such plantations are doomed. The plantations likely to prove commercially successful in withstanding the attacks of the mildew are those in which the following conditions of cultivation are found :—(1) An open situation. (2) Bushes not too closely planted. (3) Bushes of a variety that will not be injured by spraying. (4) Bushes with a natural unforced growth, such as is obtained naturally in a good soil, or by well-balanced

manuring. Over-nitrogenous manuring, *e.g.*, heavy dressings of organic manures, forces the bushes into producing sappy shoots which become virulently attacked by mildew. Experiments with the best commercial varieties should be undertaken to ascertain whether "spur"-pruning, under which system the tipping of diseased shoots (which is absolutely necessary in combating mildew) does not reduce the next season's crop, has advantages from the point of view of dealing with the present disease; or whether the abundance of young shoots which result from "spur"-pruning becomes a serious handicap. At any rate, varieties such as *Cousin's Seedling*, should be pruned in such a way as to encourage an upward growth of the branches.

With regard to the direct methods that can be employed against the mildew, it is clear that the early removal and destruction of the diseased shoots and berries is essential for success. Mildewed berries must be removed before the ripe winter-stage has formed on them. Spraying with lime-sulphur on the lines indicated below may prove to be a valuable help, but it comes second in value to the removal of the shoots and berries. If through negligence the early removal of the affected shoots and berries is not carried out, and the soil thereby becomes infested with the fruit-bodies (*perithecia*) containing the winter-spores, repeated sprayings may be powerless to save the crop or prevent outbreaks on an epidemic scale.

The lime-sulphur spray at full strength (1.01 sp. gr.) can be used during the early part of the season—April to June, and probably during July in most years—on the following varieties without causing any serious injury, even when applied several times successively to the same bushes :—*Whinham's Industry, Rifeman, Warrington, May Duke, Howard's Lancer, Gunner's Seedling, Cousin's Seedling* (*Sandwich Yellow*), and when growing in a shaded position, *Berry's Early* and *Lancashire Lad.* The following varieties are liable to be injured if the bushes are sprayed many times successively, or if they are situated in a sunny position : *Berry's Early, Freedom, Lancashire Lad, Crown Bob*; it is advisable, therefore, to use half-strength lime-sulphur (1.005 sp. gr.) on these varieties and to avoid sprayings late in the season. The varieties *Yellow Rough,*

(*Golden Drop*) and *Valentine's Seedling* show so marked a susceptibility to injury that they cannot be sprayed. In early seasons the spraying should be commenced in the middle of April, in plantations where the disease appeared in the previous season, under other circumstances, the first week in May is early enough; the spraying should be continued at intervals of about a fortnight until it interferes with the marketing of the fruit (see above, p. 423), when "liver of sulphur" solution or "flowers of sulphur" should be tried to stop the spread of mildew to the fruit. By this means it should in most cases be possible to grow a clean crop of berries. In cases, however, where the soil has become infested, it will probably be found that the berries become mildewed in spite of spraying.

Whilst spraying in May and June with lime-sulphur *before the mildew is on the bushes* appears to be with many varieties a practical way of preventing infections taking place early in the season and saving the crop, it is certain that the spraying of good-sized gooseberry bushes throughout the growing season is not commercially advisable. Even if by this means it were possible to keep the mildew entirely off the bush (which is extremely doubtful considering the constant growing out of the shoots) the cost in labour of the repeated applications would be prohibitive. It must be remembered that neither lime-sulphur nor any known spray kills the winter-stage of the mildew, and, as was observed repeatedly during 1913, outbreaks of mildew frequently occur in which the winter-stage suddenly appears almost simultaneously with the summer-stage (see above, p. 426). It is practically certain, therefore, that in every case of mildew in a plantation, some "tipping" of diseased shoots will require to be done. After the crop has been gathered, a good final spraying with lime-sulphur should be given. The mildew must then be allowed, in most cases, to attack the later growth of the shoots. By August a greater or less amount of disease will probably be found on the tips of the shoots: and this amount of disease must be expected until far more thorough and systematic methods of control are devised and generally adopted. With young and valuable Gooseberry plantations close attention to the date of the first appearance in them of

mildew and repeated sprayings to cover all the fresh growth made may render it possible to rear the bushes without having to "tip" them for disease to an extent that will seriously injure their growth. Such raising of young plantations will be possible, however, only if each season the diseased tips of the shoots are collected and destroyed in good time.

Taking everything into consideration, tipping in August or early in September, before the leaves have fallen, is strongly to be recommended in all cases where anything like a severe attack of mildew has occurred. In some seasons, and with bushes of a certain age, no further growth of the shoots will take place after the tipping is done (see above, p. 416), and then if all the mildew has been cut off, the bush stands perfectly healthy again, since the disease is strictly external and on the young wood only; if, as will be probable in some seasons, some slight fresh growth is made and this becomes infected with mildew, the grower will still be in a better position, since there will certainly be much less disease to be removed before the fruit-bodies (*perithecia*) with their winter-spores fall to the ground, or even should this happen in consequence of the postponement of the second "tipping" through an unavoidable scarcity of labour, there will be a much less severe infestation of the soil than if no tipping at all were done until October or November. On many large fruit-farms, as well as on small holdings, it is possible to find labour for the "tipping" of the shoots during the early part of August (before apple picking begins). It should be realized by the commercial fruit-grower, with the evidence which has now been collected as to the progress of the disease in this country, that it will pay better to go over infected gooseberry plantations in August and carefully remove and burn all diseased tips than to wait until late autumn, when first again there is labour for the operation. For if the tipping is done in August the diseased leaves (with their winter-spores in the fruit-bodies (*perithecia*)) will be prevented from falling to the ground, and further, the diseased shoots also will be destroyed before the fruit-bodies have begun to fall to any considerable extent from them.

With strict attention paid to the collection and destruction

of all berries which show any "winter-stage" on them*, and to the tipping of the diseased shoots in August, and by the help of spraying early in the season with lime-sulphur, it should be possible and commercially practicable to grow a crop of gooseberries free from mildew. On small holdings, and on bigger farms where gooseberries are grown in open plantations, and where sufficient labour is available at the necessary times, gooseberry growing can still be practised with hope of success, but only if the altered conditions of culture due to the introduction and establishment in this country of American Gooseberry-mildew are carefully borne in mind.

* There is no danger of the soil becoming infested from berries which have only the *white* "summer-stage" on them; but as soon as they show any *brown* "winter-stage" the crop should at once be picked and marketed, after the berries have been looked over and the mildewed ones destroyed.

OBSERVATIONS ON THE LIFE-HISTORY OF THE AMERICAN GOOSEBERRY-MILDEW.*

(*Sphaerotheca mors-uvae* (Schwein.) Berk.)

By E. S. Salmon.

The rule among the species of *Erysiphaceae*—to which the American Gooseberry-mildew belongs—is a life-cycle consisting of the production of a *conidial* stage during the growing period of the host-plant, and the production before the advent of winter of a *perithecial* stage. In the *conidial* stage the spore is a naked, short-lived *conidium*; in the *perithecial* stage the spore is an *ascospore*, which remains living for several months within the *ascus* inside the thick-walled *perithecium*.

While this is the usual life-cycle, some striking exceptions occur, particularly in cases where a species has found its way into a new continent.

When the Vine Mildew (*Uncinula necator* (Schwein.) Burr.) invaded Europe, no *perithecial* stage was found associated with it for the first forty-seven years, the mildew existing during winter in the *conidial* stage in a more or less dormant condition. Appel has shown that before winter patches of hibernating mycelium are formed on the stem of the vine; these produce *conidia* the next season. These hibernating patches have thicker-walled hyphae, and more numerous and larger haustoria. Although the perithecial stage of *U. necator* has been found within recent years on a few occasions in different years in France, Germany and elsewhere, it appears that the production of *perithecia*—which are found abundantly in America, the native home of this mildew—only takes place exceptionally in Europe—possibly under abnormal weather conditions.

* Read at the Meeting of the Association of Economic Biologists, held in London, on April 17th, 1914.

A very similar case is that of the Oak Mildew. About ten years ago oak "scrub" and to some extent oak trees also, in England and in many parts of the Continent, became for the first time attacked by a species of *Erisiphaceae* in the *conidial* stage. It received many names, *e.g.*, *Oidium alphitoides*, *O. quercinum*, etc., at the hands of mycologists belonging to that class which has sufficient time only to add to synonymy. In 1911, the discovery in France of the perithecial stage of this mildew on some autumnal shoots of the oak proved its identity with an endemic American form of *Microsphaera Alni* (Wall.) Salm., which occurs commonly, on species of *Quercus* in the United States. Here, again, quite exceptional seasonal conditions would seem to be necessary for the formation of the perithecial stage of this mildew when introduced—as presumably has been the case—into Europe from America. No perithecia have been found in this country and certainly as a general rule the oak mildew passes the winter in the conidial or mycelial stage in a more or less dormant condition.

A third case is the mildew which attacks the foliage of that very useful ornamental shrub *Euonymus japonicus*. This mildew first appeared in England, and also on the Continent, about fifteen years ago, and only the conidial stage is known.* It is possible that it is a form of *Erysiphe Polygoni* endemic to Japan on *Euonymus japonicus*, and that it has been imported with that shrub from Japan into Europe. The mildew exists in Europe during the winter-months on the evergreen leaves in dormant or nearly dormant hibernating mycelial patches which on the advent of a warm spell of weather soon produce *conidia*.

What now are the facts with regard to the life-cycle of the American Gooseberry mildew (*Sphaerotheca mors-uvae* (Schwein.) Berk.) in this country since its introduction into Europe from America about 1900? Has its normal life-cycle been interfered with in any way as the result of new factors such as change of climate or different "constitutional" characters of its host-plants? There is, I think, some reason for thinking that it has. There is no evidence that there is any hibernation of the conidial stage. The perithecial stage—

* Salmon, E. S.; "Fungous Diseases of *Euonymus japonicus*" (Journ. Roy. Hort. Soc., XXIX., p. 434, 1905).

or at least the outward signs of it—is formed abundantly on the surface of the young shoots of the gooseberry. It has been assumed from the first—and quite rightly so under the circumstances—that the continuance from year to year of this new and most destructive pest was everywhere ensured by this abundant production of the perithecial stage. Some facts which I have lately observed, however, show the necessity for close investigations to be made to ascertain to what extent the perithecial stage which is formed at different times during any one season remains living through the following winter and is the cause of the first spring outbreaks. The facts lately observed seem to show that there is a real danger—if the American Gooseberry-mildew orders are carried out by officials without the guidance of a mycologist—of fruit-growers being prosecuted and fined for not removing from gooseberry bushes *the mildew in a dead condition.*

In August last year, and during the present spring, I have observed the various details connected with the dehiscence of the ripe perithecium and the discharge of the ascospores—a process which I have not before succeeded in observing and one which, I believe, has escaped other investigators. These details are described below (p. 439). The dehiscence of the ripe perithecium was observed to take place in material collected last August, a few hours after the perithecia had been supplied with moisture; similar material, collected in November last, and kept dry in the laboratory through the winter, proved when examined in February, March and April to be alive, and the perithecia dehiscing when supplied with moisture.

This living material was useful in affording a comparison with examples of the perithecial stage obtained from bushes in the open in the spring, *i.e.*, after it had "wintered." In all cases, so far, such "over-wintered" material, which has been obtained from N., Mid., and E. Kent,* proved in February or later to be dead. In such material the perithecium on being pressed open usually exudes drops of an oily nature; the ascus is not turgid, and is often more or less crumpled; the ascospores are filled with some oily material, staining pink with

* Most of this material was kindly sent to me by Mr. F. G. Cousins, Inspector for American Gooseberry-mildew for Kent.

alkannin. No development can be induced on "incubation" at temperatures which cause living perithecia to dehisce and discharge their spores, and it is clear that such perithecia are dead.

Another lot of material was collected at the end of April, from Farnham, Newdigate and Witley. Thirty-four shoots bearing patches of the perithecial stage were sent; they were all microscopically examined. Twenty-two shoots bore patches of deep brown persistent mycelium, which on examination proved to be either quite barren with no perithecia, or with just a few (dead) perithecia. The appearance of the barren patches suggested that no peritheca had ever been formed, *i.e.*, that the development of the winter-stage had been stopped, and not that the perithecia had fallen out from them, since the densely interwoven mycelial patches showed—in many cases at all events—no signs of having been worn thin or disintegrated under the action of weather conditions; in a few cases the mycelial patches may have been partly worn away as the result of "weathering." On more than fifty per cent. of these diseased shoots there was a completely barren, although dark brown, mycelium. In the remaining twelve examples perithecia had been produced abundantly on the shoots, but in no case was a living ascus found inside any perithecium. In several cases the perithecia had apparently never reached their full development, since the ascus was not the normal size; in those cases where a full-sized ascus was present, it was without exception shrunken and obviously dead, and the ascospores, which contained oil-drops, were evidently undergoing a process of degeneration.

On May 4th a commercial plantation of *Berry's Early*, near Rodmersham, Kent, was visited at a time when the American Gooseberry-mildew was just beginning to appear for the first time this season. A number of bushes were found with the (conidial) summer stage of the mildew developing, mostly on the young green berries. In a considerable number of cases—perhaps in the majority of cases—the affected berries were in close proximity to portions of last year's shoots which were badly infested with the ("over-wintered") perithecial stage. On microscopical examination, however, of nine of these shoots, *i.e.*, where mildewed berries occurred

close to the winter-stage formed in 1913—all the perithecia appeared to be dead, the ascus being either shrivelled or empty, or when containing ascospores the ascus was not turgid, and the spores were full of oily degeneration products. The perithecium on being pressed open usually exuded drops of some oily substance.

On other branches of the bushes which bore the mildewed berries, and also on other adjoining bushes where no mildew occurred yet, the perithecial stage of 1913 could be found not uncommonly on several of the young shoots (although the bushes had been gone over twice in the process of " tipping "). As in the above-noted cases, the perithecial stage consisted of the dark-brown persistent mycelium, often considerably worn away by " weathering," and hundreds of closely aggregated perithecia. Thirty-two of these shoots with the perithecial stage were examined, and not one perithecium could be found with a living ascus. The experiment was made of incubating some of this material at 27° C., but no change resulted.

On May 6th a commercial plantation of *Cousin's Seedling* near Sandwich, Kent, was visited. This plantation was so virulently attacked by the mildew in 1913 that practically all the young shoots in every bush became infested with the winter-stage, and this also was developed on nearly every berry—the whole crop was lost, not a single berry being fit to pick. An examination on May 6th showed that the disease was just re-starting for the season; from forty per cent. to fifty per cent. of the bushes (250 in number) bore a few berries with small patches of the conidial " summer-stage " on them. In a few cases young shoots more or less plentifully infested with the perithecial stage of 1913 were closely adjacent to these mildewed berries. Nine of these shoots were microscopically examined, but no perithecium containing a living ascus was found. In the majority of cases the ascus was empty and shrivelled; in a few cases where ascospores occurred, the ascus was not turgid, and the spores were full of oily contents, and evidently undergoing a process of degeneration. In a very few cases the perithecium contained the spores of the parasitic fungus *Ampelomyces quisqualis*, but it was clear that the mildew had not been

parasitised to any appreciable extent. With regard to the bushes generally, the mildewed berries were found either on branches from which all the young wood (which had probably been diseased) had been cut away, or on spurs on quite old wood.

Since there is no evidence that in these cases the primary infections have been caused by ascospores from the "over-wintered" material still present on some of the shoots, the explanation must be looked for in another direction. There are two other ways by which infection by ascospores could have occurred. As I have pointed out (see above, p. 424), perithecia may begin to fall to the ground in August from infested berries and, to a less extent, from infested shoots. With regard to this particular plantation, all the berries (as noted above) became very badly infested; they were not removed by the grower until late in August, by which time not only must thousands of perithecia have fallen to the ground, but many of the infested berries had fallen or been scattered by birds; there must, therefore, have been a heavy infestation of the soil. If, however, the primary infections which were taking place in May had been caused by ascospores arising from the soil, one would have expected to find the majority of the mildewed berries on the lower branches of the bush, *which was certainly not the case, the affected berries being nearly always on the upper branches.*

The second way by which infection could have been caused is as follows. The "tipping," *i.e.*, the removal of the infested shoots was not done until the end of October or beginning of November; by this time a considerable mass of perithecia must have dropped from the perithecial patches. Many of these perithecia would doubtless lodge in the crevices of the bark, or between the bud-scales, etc., and assuming that these perithecia (developed, perhaps, in the *first-formed* patches) were mature ones capable of remaining dormant through the winter, these would on liberating their ascospores, infect the adjacent berries. This theory, to which on the whole I incline, would account for the fact that the berries in the upper part of the bush were first attacked.

It seems clear, therefore, from the evidence given above, that some amount of the perithecial stage of the American

Gooseberry-mildew which is produced in this country either does not reach maturity or does not survive the winter.

It is possible, but I think very unlikely, that in those cases (mentioned above) where an examination in the spring showed only perithecia with dead asci that all the mature (living) perithecia had fallen previously to the ground. It seems far more probable that this material had never reached that stage of development at which the perithecia can remain alive through the winter. If so, the reason for this failure to mature may be due to the influence of new factors which the mildew encounters in this country, such as the "constitutional" characters of European varieties of gooseberries, or to the weather conditions obtaining in this country in the late summer or autumn. It may possibly prove to be the case that it is only the perithecial stage which is formed early in the season reaching maturity about July or August, that is really dangerous, and that later-developed perithecia do not survive the winter.

It would of course be unwise to generalize from observations—made so far on material obtained in one season only; but there seems clear evidence that both the fruit-grower and the official administrators of the American Gooseberry-Mildew Orders have a new fact to reckon with, viz., the natural death before the spring of some amount of the perithecial stage of the American Gooseberry-mildew.

OBSERVATIONS ON THE PERITHECIAL STAGE OF THE AMERICAN GOOSEBERRY-MILDEW.*

(*Sphaerotheca mors-uvae* (Schwein.) Berk.)

By E. S. Salmon.

So far as I am aware, the manner of the dehiscence of the perithecium of *Sphaerotheca mors-uvae* has not hitherto been described.

During the spraying experiments against the American Gooseberry-mildew which were carried out last year in Kent, it was observed that the fully developed winter-stage occurred on both the berries and young shoots of gooseberry bushes at the beginning of August. The perithecia, which were perfectly mature, readily separated from the persistent mycelium; indeed, a considerable number were already loose, as was shown by the fact that if infested berries were held over a white sheet of paper and gently tapped, the perithecia fell in dozens on to its surface. The separation of the perithecium from the mycelium at this early date is a point of considerable practical importance in the control of the disease, indicating as it does the absolute necessity for the collection and destruction of mildewed berries before the winter-stage has matured on them, as otherwise the soil will become infested. Perithecia from this material when supplied with moisture were found to dehisce and eject the ascospores within a few hours. It seems probable, therefore, that in some cases the ascospores of *S. mors-uvae* may serve to spread the disease in the same season in which they are produced, as I have proved is sometimes the case with *E. Graminis*.

Similar material, showing the fully-developed winter-stage, was collected in November last, and it has been found that

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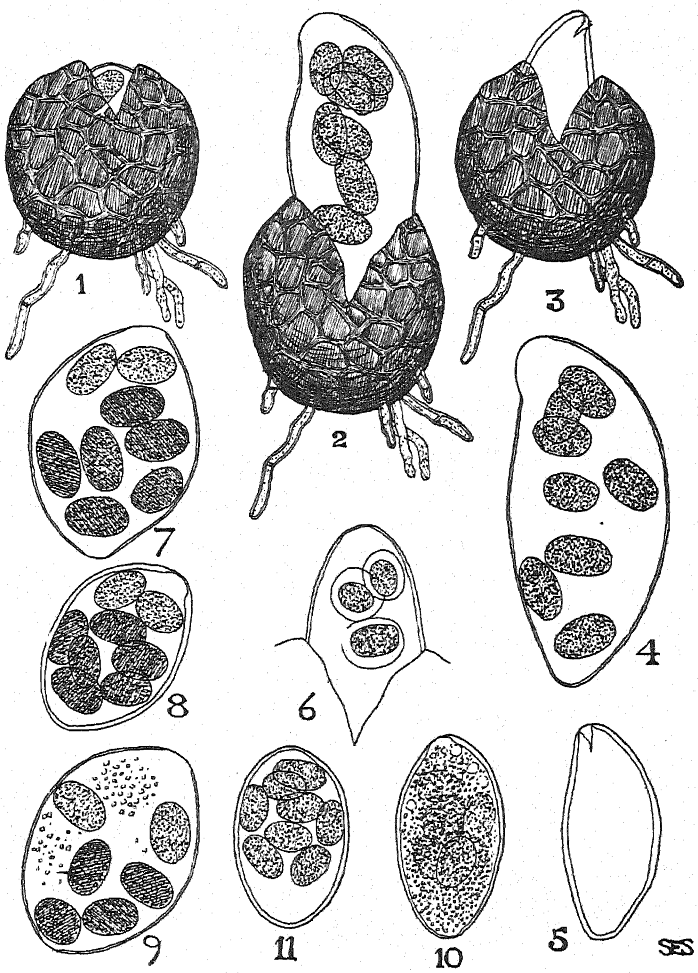
this, when kept dry in the laboratory (temperature about 15° C.) remains living through the winter. In February many of the perithecia when supplied with moisture opened and the ascus discharged its spores,—the whole process taking place within a few hours. The manner of the dehiscence of the perithecium and the swelling up of the ascus and discharge of the spores, as it takes place in a drop of water, can be seen on reference to Figs. 1 to 3, drawn under the microscope. A small more or less vertical slit appears at the apex of the perithecium, allowing at first only the tip of the enclosed ascus to be seen (see Fig. 1). The ascus rapidly absorbs water and swells considerably, emerging more and more into the open, and thereby exposing to view its ascospores. Through the forcible swelling of the ascus, the slit in the walls of the perithecium is enlarged. In about five minutes the ascus has swollen enormously, being now often double the length of what it was inside the perithecium (see Figs. 2, 4, 5). In the process of swelling its wall naturally becomes thinner and thinner; finally the tension becomes so great that the wall is ruptured near the apex of the ascus, at a place where from the first the wall is much thinner, forming there a kind of "pore" (see Fig. 9). Through the slit the eight ascospores are forcibly shot out all together. I have seen them expelled through water to a distance of about ten times the diameter of the perithecium, and from a perithecium laid on wet filter paper the spores will be discharged to a distance of 2.5 cm. The ruptured and empty ascus, greatly reduced in size, shrinks back into the perithecium, the walls of which at the slit come nearer together (see Fig. 3). If, as sometimes happens when the perithecium is in water, the ascus gradually emerges entirely from the perithecium, the process of the discharge of the spores takes place in the same way.

The length of time taken by the ascus in discharging its spores (when the perithecium is immersed in water) varies, as the following observations show.

Obser. 1. 12.53 p.m., Perithecium dehisced; apex of swelling ascus just visible (as in Fig. 1). 12.54 p.m., ascus emerged sufficiently to show 3 ascospores. 12.55 p.m., 6 ascospores visible. 12.57 p.m., clear vacuole-like spaces (see below) now apparent round most of the spores. 1 p.m., 8 ascospores now visible; ascus fully extended (as in Fig. 2). 1.5 p.m., ascospores discharged.

Obser. 2. 3.43 p.m., Perithecium dehisced. 3.44 p.m., ascus emerging and showing 2 of the ascospores. 3.45 p.m., ascus further emerged, and showing 4 ascospores, with clear vacuole-like spaces round two of them. 3.48 p.m., 8 ascospores visible, most of them surrounded by clear vacuole-like spaces. 4 p.m., ascus apparently fully extended, wall very thin. 4.29 p.m., ascospores discharged.

In a third case, the length of time from dehiscence to expulsion was 11 minutes.



EXPLANATION OF FIGURES.

FIGS. 1—3. A perithecium of *S. mors-uvae* (in water), showing the manner of the dehiscence and discharge of the ascospores. Fig. 1. The wall splits at the apex of the perithecium, exposing to view the apex of the ascus, which immediately begins to swell up and protrude Fig. 2. The stage reached in about five minutes; the ascus has now swollen to about six times its original volume, and in so doing has enlarged the opening in the wall of the perithecium; the wall of the ascus in consequence of the enlargement has become very thin and is in a state of great tension. The ascospores are clearly visible in the hyaline contents of the ascus. Clear vacuole-like spaces (not shown here) are formed round the spores during the process of the swelling of the ascus (see Fig. 6). When the ascus has swollen to its full extent, the wall, after a little time, splits by a slit at the apex, at a place (or "pore") where from the first the wall is thinner (cf. Fig. 9), and the ascospores, all together, are forcibly expelled. The empty and shrunken ascus, now showing again the thick wall, retreats partly into the perithecium, the walls of which draw together somewhat at the opening.

FIG. 4. A fully swollen ascus, which has slipped out of the perithecium into the surrounding water.

FIG. 5. The same ascus as in Fig. 4, after it has discharged its ascospores.

FIG. 6. A ripe ascus beginning to swell up; clear vacuole-like spaces are formed round the ascospores.

FIG. 7. A ripe ascus swollen up in water; on treatment with the neutral red stain, six of the ascospores (shown shaded) became deeply stained, while two remained unstained.

FIG. 8. The same ascus, contracted on treatment with a solution of common salt.

FIG. 9. The same ascus on treatment with distilled water; two of the stained ascospores burst.

FIG. 10. An ascus, which was previously of the size and appearance shown in Fig. 2, contracted as the result of pressure (see p. 445). The contents (excluding the ascospores), which were before hyaline, are now densely granular, so that the outlines of the spores are almost hidden.

FIG. 11. The same ascus as in Fig. 10; after treatment with a solution of common salt, which causes the granular substances to dissolve.

The following facts are summarized from Exper. 2, given below in detail (see p. 444). Perithecia continued successively to dehisce over a period of nineteen days, after variations of temperature from 15.5 C. to – 1° C. With a temperature as low as 4.5° to 3° C., and as high as 27° C., the perithecium dehisces and discharges its spores. A temperature of –1° C., repeated five times, does not kill the ripe, or nearly ripe, perithecium.

In the following experiments the perithicia were kept on wet filter paper in a Petri dish, and placed so as to be about 5 mm. below the lid. The ascospores on being expelled were caught either in the drops of condensation on the lid or in agar, and were counted under the microscope and then removed after each observation.

Exper. 1. At 10.30 a.m. Feb. 12th, material of the winter-stage (taken from bushes last November, and subsequently kept dry in the laboratory) was wetted and placed immediately on wet filter-paper in three Petri dishes. These were put in the following positions: (1) out-of doors, in the shade. The maximum temperature during the day was 13° C.; (2) in the laboratory, temp. 15° to 16° C.; (3) in an incubator, temp. 27° C. By 12 noon the number of ascospores which had been discharged was as follows: (1) 16; (2) 45; (3) several hundreds. By 3 p.m. several hundreds had been discharged from (1) and (2).

Exper. 2. The dry material* was wetted at 11.15 a.m. on Feb. 13th and at 11.33 a.m. was placed in Petri dishes in the same positions as in *Exper.* 1. The number of ascospores *successively discharged*, and the variations of temperature, are shown in the following table (see p. 444).

The ascospores germinated normally after being kept for some hours in water.

The living ascus has the power of swelling and shrinking several times. If a current of a 2.5 or 5 per cent. solution of common salt is drawn through water in which there is an ascus which has swollen out as shown in Fig. 2, the ascus shrinks very rapidly, and the progressive thickening of the wall in consequence can be clearly seen under the microscope. (Cf. Figs. 7, 8, 9.) If distilled water is now added, the ascus at once begins to enlarge again, the cell-wall becoming thinner

* To secure as far as possible uniformity of the material as regards degree of maturity, every patch of mycelium (with its perithecia) taken from the shoots were divided into three portions, and one piece placed in each Petri dish. This was easy to do, as the patches were from 5 to 8 mm. long. The total size of the material placed in each Petri dish was 1 x .5 cm.

EXPERIMENT 2.

Time of examination.	1		2		3	
	Temp. ° C.	No. of spores.	Temp. ° C.	No. of spores.	Temp. ° C.	No. of spores.
Feb. 13, 12.30 p.m.	10	0	14	0	27	8
,, 1.0 ,,	10.5	0	14.5	0	27	15
,, 2.0 ,,	11	12	15.5	20	27	98
,, 2.30 ,,	10.5	30	15.5	42	27	34
,, 3.30 ,,	10	21	15	42	27	67
,, 4.30 ,,	9	15	15	110	27	20
,, 5.30 ,,	9	34	15	35	27	5
,, 9.0 ,,	10	over 200	15	over 100	27	30
Feb. 14, 9 a.m.	10—7*	bet. 500 & 600	15	about 200	27	0
,, 1 p.m.	12	about 200	17	8	27	10
,, 5 ,,	10	about 150	17	10	27	0
,, 10 ,,	11	18	17	0	27	0
Feb. 15, 9 a.m.	11—8.5	64	15	0	27	0
,, 2 p.m.	11	16	15	0	27	0
,, 9 ,,	7	0	15	0	27	0
Feb. 16, 9 a.m.	7—4	9	15	0	27	0
,, 9 p.m.	6.5	8	15	0	27	0
Feb. 17—18. Not observed	—	—	—	—	—	—
Feb. 19, 2 p.m.	***	about 30	15	0	27	0
,, 9 p.m.	6.5	8	15	0	27	0
Feb. 20, 9 a.m.	6.5—1	8	15	0	27	0
,, 9 p.m.	7.5	8	15	0	27	0
Feb. 21, 9 a.m.	9—5	8	15	0	27	0
,, 9 p.m.	9—4**	8	15	0	27	0
Feb. 22, 9 p.m.	—	16	15	0	27	0
Feb. 23, 9 a.m.	4.5—3	16	15	0	27	0
,, 9 p.m.	9—4.5	8	15	0	27	0
Feb. 24, 9 a.m.	6.5— -1	0	15	0	27	0
,, 9 p.m.	13—2	2	15	0	27	0
Feb. 25, 9 a.m.	4.5—3	0	15	0	27	0
,, 9 p.m.	12—2	3	15	0	27	0
Feb. 26, 9 a.m.	5.5— -1	0	15	0	27	0
,, 9 p.m.	9—0	0	15	0	27	0
Feb. 27, 9 a.m.	3.5— -1	0	15	0	27	0
,, 9 p.m.	15.5— -1	0	15	0	27	0
Feb. 28, 9 a.m.	5.5—0	0	15	0	27	0
,, 9 p.m.	13—3	8	15	0	27	0
March 1, 9 a.m.	8—2	0	15	0	27	0
,, 9 p.m.	14.5—4.5	0	15	0	27	0
March 2, 9 a.m.	5.5—.5	16	15	0	27	0
,, 9 p.m.	—	0	15	0	27	0
March 3, 9 a.m.	5.5—0	0	15	0	27	0
,, 9 p.m.	10.5—2	6	15	0	27	0

* Maximum and minimum readings between 9 p.m. and 9 a.m.
** ,, ,, ,, ,, ,, 9 a.m. and 9 p.m.
*** The max. and min. readings between Feb. 16, 9 p.m. and Feb. 19, 2 p.m., was 10° C.—1° C.

and thinner, until the ascus attains its original volume. The process can be repeated several times, both with asci partly included in the perithecium and when free in the water.

In all cases observed the ripe ascus, *i.e.*, one capable of swelling up in water and discharging the spores, is (with the exception of the granular ascospores) hyaline (see Figs. 2, 4). During the process of the absorption of water, clear vacuole-like spaces arise round the ascospores (Fig. 6). These clear spaces vary in shape and size, and disappear and reappear when the ascus is made to shrink or swell.

A somewhat remarkable phenomenon has been observed under the following circumstances. If a living ripe ascus with hyaline protoplasm is given a certain amount of pressure——not sufficient to rupture the wall—a change is induced in the appearance of the protoplasm (epiplasm), which now becomes opaque and densely granular (and often somewhat vacuolate or "frothy") so that the outline of the ascospores is nearly lost. (Cf. Figs. 10 and 11.) If the ascus at the time of treatment has swollen up in water, the pressure must apparently expel some fluid from the ascus, since its volume after the treatment is much smaller. The ascus is now, as far as I have observed, rendered incapable of swelling to the normal proportions and discharging its spores. If a solution of salt is now added, some amount of further shrinking takes place; the granular substances ars dissolved very rapidly, and the ascospores are again visible, surrounded by the protoplasm as hyaline or almost as hyaline as before. If now distilled water is added, the hyaline protoplasm again becomes densely granular, this change taking place almost instantaneously. The process can be repeated many times. Experiments are now being made to ascertain the nature of these changes.

During 1913 the mildew was found beginning to develop the winter-stage as early as May 26th; by June 6th the winter-stage was found in abundance well-developed on the berries of a number of varieties of gooseberries. The winter-stage may be formed almost at the beginning of an attack; in one case (observed in a commercial plantation in Kent) the process of inoculation, incubation and the development of both the summer- and winter-stages occupied only eleven days.

THE "BROWN ROT" CANKER OF THE APPLE.

By E. S. Salmon.

In this *Journal* for 1910, the fact was pointed out that the fungus (*Sclerotinia* (or *Monilia*) *fructigena*) which causes the disease known as "Brown Rot" affecting the flowers and fruit of Plums, Cherries, Apples, Pears, Medlars and Peaches, is sometimes the cause of a definite "canker" in the branches of the Apple. Investigations showed that this "canker" injury may arise in two ways. Either the apples of the tree affected, when they are developing, are attacked by the "Brown Rot" fungus, with the result that the flesh of the apple becomes permeated by the spawn (*mycelium*), while pustules of spores (*conidia*) are produced on the outside. Many of these diseased and more or less rotten apples fall to the ground, but it is not uncommon to find some of them remaining on the tree, firmly attached to the spur or branch, throughout the winter right on to the following spring (see Plates IV. and V.). The apples which remain on the tree in this way are in a dried-up "mummified" condition; the spawn of the fungus, however, remains alive, and is capable, under suitable weather conditions, in the following year, of renewed growth, and the production of pustules of spores. In some cases diseased apples, when rotting under the attacks of the fungus, press against the part of the branch near the spur on which they are borne, and remain fixed for months in this position, the decaying flesh of the apple at first softening and then hardening, and, as it were, glueing the apple firmly to the branch. Under such conditions the spawn of the fungus grows from the diseased apple into the branch, and produces there a local

" canker "-like injury. In the following spring, or even during the winter if it is a mild season, pustules of spores are developed over the cankered area, breaking out through cracks in the bark from the underlying spawn. Sometimes the branch becomes completely girdled at the " canker," when of course the upper part of the branch dies ; this, however, rarely occurs in the case of large branches, but is frequent with the smaller twigs.

The second way in which the " Brown Rot canker " can arise on a branch is by the spawn of the fungus directly travelling into the wood from the fruit-spur, which has become diseased through its flowers or fruit having been attacked. The spur is killed, and the spawn travels from its base into the branch and forms there a " canker," from which the dead spur projects as a " snag " (see Plates VI. and VII.). In such cases the dead remains of the spur almost invariably bear numerous pustules of spores (see Plate VIII. and IX.).

During the past autumn and spring, outbreaks of Brown Rot on Apples have occurred to an unusual extent. In very many cases the attack has resulted in the formation of " canker " in the branches. As previously noted, the attack on the wood proceeds sometimes from the fruit and sometimes from the blossoms. Typical cases of the first method of attack were seen last autumn in several plantations near Maidstone. The variety was James Grieve ; a considerable number of the apples (which are soft-fleshed in this variety) were attacked just before ripening, and turned rotten. The spawn (*mycelium*) of the fungus invaded the cortical tissue of the spurs bearing such apples, and eventually entered the branch, soon producing in the part surrounding the spur a " cankered " area, where the bark cracked. In the cracks of the bark all over the " canker " pustules of spores were produced in abundance during the winter and spring. In some cases where a number of contiguous spurs were attacked, the " canker " resulting was as much as one foot in length, and from such a " canker " several dead spurs, showing where the fungus obtained an entrance, will project (see Plates X. and XI.).

More frequently, however, in the cases which have recently come under observation, the disease has commenced by the

fungus attacking the tree when in flower. A number—often a very large number—of flower-spurs are attacked, and then the fungus in the course of a few weeks enters the branch through the dead or dying spur. This kind of attack has taken place on a large scale in plantations of Cox's Orange Pippin and Lord Derby. The photographs at Plates XII. to XV. are of a branch of a tree of Cox's Orange Pippin, on which dozens of flower-spurs were attacked and killed; round the base of these spurs "cankers" arose, in the cracks of which pustules of *Monilia*-spores were freely produced in June. As these photographs, taken from each side of the branch, show, the canker has completely girdled the branch.

I am informed by Prof. H. H. Whetzel, Professor of Plant Pathology in Cornell University, U.S.A.,—to whom I recently showed some affected trees—that except for the occurrence of pustules of spores in the cracks, these injuries produced in the branch by the "Brown Rot" fungus, when it enters by the flower-spur as described above, are exactly similar to that caused by "Fire Blight" (*Bacillus amylovorus*)—an extremely destructive disease from which this country is at present fortunately free.

The varieties on which I have observed the "Brown Rot Canker" are as follows:—Cox's Orange Pippin, Lord Derby and James Grieve (all severely attacked): Worcester Pearmain, Ecklinville Seedling, Beauty of Bath, Ribston Pippin and Warner's King, less severely attacked.

With regard to remedies, where trees have been noticed to be affected in the previous season, all dead wood and cankers should be cut out, and the trees well sprayed with Bordeaux Mixture (4 lbs. quicklime, 4 lbs. copper sulphate, 50 gallons water), *just before* the flower-buds open. When the disease has been bad, a second spraying should be given *directly* the bloom has set, using Bordeaux Mixture or the lime-sulphur wash according to the variety of Apple. (The latter spray for Cox's Orange Pippin.) Where flower-spurs are observed to be attacked in the spring, I would strongly advise growers to cut them off immediately and burn them, as this measure *carried out in time* removes the disease before the fungus has time to grow into the branch. Besides the actual damage to the branches caused locally by the

formation of cankers, the cankered areas and the dead spurs projecting from them must be regarded as highly dangerous to the health not only of apple-trees, but of surrounding fruit-trees, such as Plums and Cherries, since pustules of spores are produced on them practically all the year round.

NOTES ON SOME FUNGOUS DISEASES.

By E. S. Salmon and H. Wormald.

1. A New Disease of Apple Buds.

In the last Report the occurrence of a new disease affecting apple buds was reported. The diseased apple-trees, growing at Chart Sutton, near Maidstone, were of the variety Grenadier and Bramley's Seedling, and in 1912 and 1913, some of the branches on the first named variety suffered to the extent of over fifty per cent. of the flower-buds being killed. In all cases microscopical examination showed the presence of the mycelium and spores of a fungus belonging to the genus *Fusarium*. For further details, and also for photographs of the diseased buds, reference may be made to last year's Report.

In April of the present year, Mr. H. B. Teagle, of Wisbech, Cambridgeshire, sent us for examination some diseased apple-buds; these proved to be infested with the mycelium of the same *Fusarium*. Mr. Teagle, who considers that the present disease is a serious one in the neighbourhood of Wisbech, and decidedly on the increase, sends the following information :—" We first noticed the disease here about three seasons ago, but only a small percentage of the buds were then attacked—the trees being of the variety Emneth Early. I may say here that the trees which I have noticed to be worse attacked are of the Codlin type, or soft wooded sorts. As far as I have observed, it is chiefly confined to the lower branches, and although we have had a comparatively dry season the last two years, and the trees have been winter-sprayed with lime and lime-sulphur solution, the disease has increased rapidly each year. After three years its effect is very apparent at a distance, causing the blossom buds to fail to develop, the lower branches having only a few blossoms on, and looking quite bare; some of the buds shrivel up and

remain on the tree, while others appear to fall. I do not think it affects the leaf buds, because I have noticed that when the flower-bud has fallen, the spurs shoot out about two leaf buds immediately at the side. The varieties which I have noticed to be affected this season are as follows :—

"Emneth Early. About 25 per cent. buds, lower branches.

"Worcester Pearmain. About 25 per cent. buds, lower branches.

"Lord Grosvenor. About 8 per cent. buds, lower branches.

"Lane's Prince Albert. About 8 per cent. buds, lower branches.

"Allington Pippin. A small percentage.

"Bramley's Seedling. A small percentage.

"In my experience Bramley's Seedling has only just begun to suffer from the disease."

In May, 1913, Professor B. T. P. Barker, Director of the Long Ashton Fruit and Cider Institute, announced the discovery of a bacterium which causes the blackening of pear blossoms, producing the injury commonly attributed to the action of frost or cold winds. In a more recent paper* on the subject, it is stated that there is reason to believe that a number of other plants are susceptible to attack. "A bacteriological examination of discoloured parts of flowers of apples, cherries, gooseberries and plums has been made, and in many cases there has been found in the diseased areas a bacillus in practically a pure state, which on isolation has proved to be the same organism as that occurring on the diseased pear flowers." "In the case of apples, discoloured flowers of Beauty of Bath, Bramley's Seedling, Allington Pippin, Devonshire Quarrenden, and Duchess of Oldenburgh have been examined, and from each sort the bacillus has been isolated."

It is mentioned that rarely other organisms appeared on the plate cultures, and in such cases the foreign form was nearly always *Monitia fructigena*, the "brown rot" fungus. It is not uncommon to find flowers attacked at the same time both by this fungus and the bacillus. No mention is made of the occurrence of a *Fusarium* in any of the material examined.

* "A Bacterial Disease of Fruit Blossom." By B. T. P. Barker and Otto Grove (Annals of Applied Biology, vol. I., p. 85, 1914).

Some of the apple-buds sent by Mr. Teagle were submitted for examination to Professor Barker, who reported: "Mr. Grove has examined the buds which you sent, and has obtained very numerous colonies of our Fruit Blossom Bacillus from them, in addition to your *Fusarium*. At present I am not sure how much of the damage is to be attributed to *Fusarium*, and how much to Fruit Blossom Bacillus. Very possibly, since the latter appears to be very widely spread, and has been found by us on perfectly healthy parts of plants, the *Fusarium* may be the actual cause of all the trouble, and the presence of the bacillus accidental."

In our first account of this disease on apple-buds we wrote: "In a few cases bacteria have been observed in the gummy fluid which often oozes from the brown dead cells of the bud-scales when placed in water." Future investigations will decide as to whether the *Fusarium* or the bacillus is the primary cause of the death of the apple bud.

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2. **Celery "Blight."**—(*Septoria Petroselini* var. *Apii.*)

In the account given in the last Report of the now very prevalent disease of Celery, known as "Blight" or "Rust," we wrote: "The disease is usually present on celery plants quite early in the season, and—just as with potato 'blight'—if the grower waits until late in the season before taking remedies, the case is hopeless. The erroneous idea of its late appearance on the plant has probably arisen from the fact that the evident 'wilting' and death of the leaves does not take place usually until July or later, although an examination of the plants in June will generally show the presence of the fungus on many of the leaves." Photographs were given from a seedling celery plant, showing that the disease may be present on these as early as the first week of May. For the life-history of the fungus which causes Celery "blight," and for the remedies which have proved successful in dealing with the disease, reference may be made to the Report; the purpose of this note is to call attention to the fact that Celery *seed* may be infested with the fruit-conceptacles (*pycnidia*) of the fungus *Septoria* which causes the "blight." In such cases as the photo-micrograph at Plate XVI. shows, little black "dots"—the fruit-conceptacles (*pycnidia*) of the fungus—can

be seen (using a pocket magnifying-glass) on the surface of the seed or of the piece of stalk attached to them. It is probable that the sowing of seed bearing the fungus is the principal means by which the disease is distributed. When such seed is planted, outbreaks of the disease *in the seed-bed* may be expected to occur. It would probably be a good plan, when the disease is noticed on the seedling plants, to dip them in Bordeaux mixture at the time of transplanting them to the trench.

Last Spring commercial samples of seed* of the following varieties were found to be infested with fruit-conceptacles (containing *spores*) of the fungus: Solid White, Sandringham Dwarf White, Clark's Extra Early Market—all badly infested; also on Sutton's White Gem, and Bibby's Defiance White.

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3. **The White Root Rot.**—(*Dematophora necatrix* Hedw. *Rosellinia necatrix*, Prill. and Del.)

In January last we received the following communication from a fruit-grower near Canterbury: "We are sending you an Apple tree, with some of the soil attached, taken up from our plantation at Harbledown, for examination. There are several patches of a rod or so each, in this plantation, from which we have grubbed old Cherry trees, and on which we can get neither bushes or trees to live since the grubbing. The tree we are sending you is a Lord Derby, and we have had Beauty of Bath, and Bramley's Seedling, and also Gooseberry bushes die after a year or so, on the same patches. We shall be glad if you can give us any information as to the cause of the trees and bushes dying, and whether you can suggest any special treatment of the soil to prevent the same."

The examination of the tree sent revealed the presence on the surface of the roots of strands of white matted mycelium (see Plate XVII.). Under the microscope the threads (*hyphæ*) of this mycelium showed the characteristic structure of those of the White Root Rot Fungus, *Dematophora necatrix* Hedw. (see Fig 1). Under certain circumstances this fungus is very destructive to fruit trees and bushes; a visit was therefore paid to the farm to ascertain the local conditions.

* Samples of Celery seed suspected of carrying the disease may be sent to the College for examination free of charge.

The piece of ground affected was between two and three acres in extent. A number of old Cherry trees growing on it had been grubbed up several years ago, many of the deeper roots being left in the ground. Apples and Gooseberry bushes were then planted, and the presence of the disease became noticeable through the death season after season of some of the young Apple trees and also of the Gooseberry bushes. Apple trees were re-planted from time

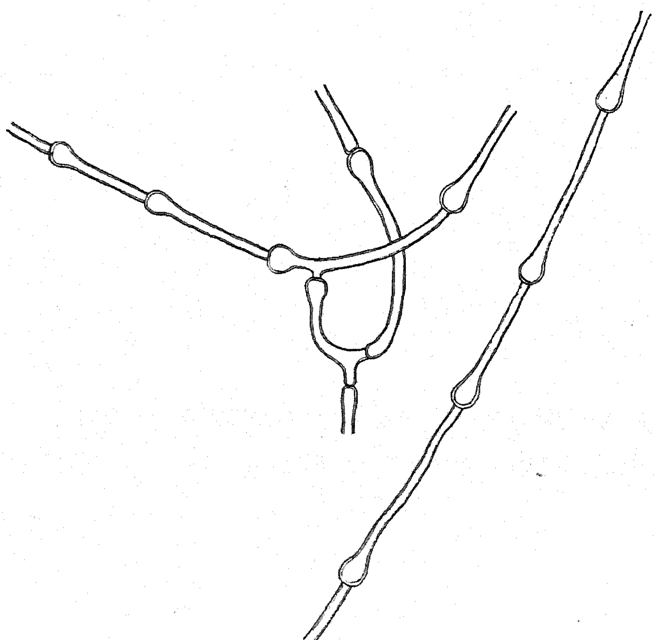

Fig. 1.

to time, but finally the remaining Gooseberry bushes (" Yellow Rough ") over the whole piece were grubbed up. This process was accomplished by attaching a chain to the bush and dragging it out, an operation which necessarily left in the ground a considerable number of the roots. In digging the ground from time to time portions of these old Gooseberry roots were brought to the surface, and at our visit we noticed several on the surface of the soil, or

protruding from it. On such roots the mycelial strands occurred in profusion, and subsequent microscopical examination showed that they were those of the White Root Rot Fungus. There was clear evidence, therefore, that this fungus was persisting in the ground on the old roots of the Gooseberry bushes, and from these attacking the young Apple trees as they were planted. The plantation was dug by piece work, and consequently no efforts had been made to clear the ground of old roots. Following the advice given, the treatment of the plantation in the future will be as follows :—Trenching of the ground, with the collection and burning of all old roots, and the necessary subsequent diggings (not by piece work), attention always being paid to the removal, as far as possible, of old roots. It is only by such measures that ground once infested can be cleared from a root parasite such as the present fungus.

The Board of Agriculture on June 18th, 1908, by their "Destructive Insects and Pests Order of 1908" made the White Root Rot a notifiable disease. This was an ill-advised step, since the present disease is neither a new disease nor one highly infectious. The Board have since realized their mistake, and we find that in their more recent Order, the White Root Rot is omitted from the list of diseases which the fruit-grower is now required by law to notify.

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4. Leaf Spot of Cabbage and Broccoli.—*Mycosphaerella brassicicola* (Duby) Lindau.

This fungus, frequently found during the winter months on leaves of species of *Brassica* (see Plate XVIII.), is considered to be the "perfect stage" of a conidial form *Phyllosticta Brassicæ* which causes a "leaf-spot" on Cabbage, Broccoli and allied plants. Dr. M. C. Cook in his "Fungoid Pests of Cultivated Plants" says of this fungus :—"The mature stage of this pest, in the form of *Sphærella*, is not reached until the leaves have lain some time on the ground."

Observations made at this College during February and March, 1914, show that this statement requires modification, for in some cases the *Sphaerella* (or *Mycosphaerella*) stage with mature ascospores has been found on living green leaves of Cabbage an Broccoli. On one occasion,

while an examination of the fruit bodies was being made under the microscope the asci were seen to elongate and eject the ascospores. The spores as shown in Fig. 2 are two-celled, spindle-shaped (*fusiform*), with rounded ends, usually slightly curved and with a slight constriction at the septum ; the septum is medial, but as a rule one cell is slightly broader than the other.

They are usually thrown out in rapid succession, though sometimes a few seconds elapse between the ejection of one spore and that of the next. While the process was under observation, one spore was caught at the middle where the constriction occurs, by the partial closing of the pore of the ascus, so that one of the two cells of the spore was outside and the other inside the ascus ; it remained in that position for a short time but was eventually ejected.

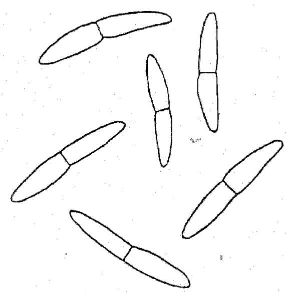


Fig. 2.
Ascospores of *Mycosphaerella brassicicola* × 650.

Green leaves of Broccoli, with the mature stage of the fungus have been sent in from Clapham, near Worthing, and from Handcross, Sussex. Our correspondent from Handcross writes : "I enclose some specimens of Broccoli leaves (variety, Late Queen). The 'spot' appears in autumn and increases in extent during winter, attacking all but the younger leaves of most of the *Brassicas* we grow ; I have not noticed it on Turnips. The disease is very prevalent all over this neighbourhood, especially in the allotments."

Living leaves of Broccoli and Cabbage obtained from the College gardens were also found to have the *Mycosphaerella* stage (with mature spores) on the diseased spots.

A HEART ROT OF CELERY CAUSED BY BACTERIA.

By H. Wormald, A.R.C.Sc., D.I.C., B. Sc.

During the summer and autumn of 1912 the celery crop in the gardens connected with this College was attacked by *Septoria Petroselini* var. *Apii*, the fungus causing the Celery Leaf Blight.* Towards the end of the season, viz., in the months of January and February, this fungus occurred not only on the upper green portions (laminæ) of the leaves but also on the bleached leaf-stalks where numerous *pycnidia* (the fructifications containing the reproductive bodies) were to be found. Leaves attacked by the *Septoria* only, usually assume, sooner or later, a wilted and withered appearance; some of those which came under observation, however, were quite soft and of a pulpy or gelatinous consistency, dark brown in colour and glistening on the surface. A particle of such material when subjected to microscopic examination was found to be swarming with actively motile rod-shaped bacteria.

It was at first thought that the bacteria were living saprophytically on the tissues primarily killed by the *Septoria*, for this fungus is known to produce a rot of celery, particularly if, after they are lifted, the plants are stored for some time before being used, as is a common custom in America. When, however, a little of the pulp was removed from the region bordering on the living tissue and examined, bacteria alone were found, there being no trace of either pycnidia or fungal hyphæ. It seemed certain, therefore, that the bacteria to be found in such a region were not living on tissues which had previously been killed by some other organism, but that they were actually attacking the living cells and were the primary cause of the decay. In all probability, when the tissues are killed saprophytic bacteria do gain an entrance and accelerate the process of decay, for although one form (and possibly a second) has been isolated which is capable of attacking

* *See* Vol. XXI., pp. 329-338, for description of this disease.

living celery plants, others have also been isolated from similar material which apparently have no power to attack the living plants even when introduced through a wound.

That bacteria are able to produce disease in plants was first demonstrated less than forty years ago. About 1880 plant pathologists began to suspect that certain bacteria were pathogenic in plant tissues and that they could, under favourable circumstances, behave as virulent parasites. Particularly interesting in this connection was the work of Burrill (2)*, who showed that the Pear Blight or Fire Blight, a disease which is very destructive to pear trees in America and which had long puzzled growers and investigators in that country, was to be attributed to bacterial action. At first the idea that bacteria could, unaided by other organisms, cause maladies in healthy plants, was considered by many as highly improbable, and even as recent as 1897 we find a prominent German investigator, Dr. Alfred Fischer (4) of Leipzig, maintaining that bacteria were unable to attack vegetable cells, even assuming that they came in contact with the more delicate internal tissues by gaining entrance through the stomata or by being introduced through a wound. Those statements were ably criticized by Dr. E. F. Smith (11), Plant Pathlogist to the Department of Agriculture in the United States, who was able to prove conclusively in papers published in 1899 and 1901 that bacteria could independently produce disease in plants. Since the latter date bacteriosis of plants has been generally accepted as an established fact; not only have the results of the pioneers in this field of work been confirmed and amplified, but many other bacteria which have been proved capable of inducing pathological conditions in plants have been isolated and described, and the number of such forms is increasing year by year. The bacteria are probably unable to penetrate surfaces protected by cuticle or layers of cork, but they may gain access to the interior not only through wounds, but also, in some cases, through the natural pores (the stomata and water-pores) or at unprotected surfaces as in nectaries.

The abnormal results brought about by these parasites are various, depending on the mode of parasitism of the

* The numbers refer to the Bibliography on pp. 472-473.

organism and the behaviour of the host plant, but in this country, and probably abroad, the most troublesome forms appear to be those which induce a "soft-rot" in the organs invaded. The final result is practically the same in all cases of soft rot; the tissues are reduced to a pulp and often the rot progresses until the whole of the plant attacked is reduced to a soft, moist, fetid mass. This type of bacteriosis includes the celery-rot observed at Wye.

Very little work appears to have been done hitherto on bacterial rots of celery and apparently only one observer has previously isolated and described a bacterium from this plant. This investigator was Brizi (1) who in 1896 described a celery-rot in Italy, and from the material obtained a form which he named *Bacterium Apii* [=*Bacillus Apii* (Brizi) Migula]. The disease, which at that time was causing considerable damage in that country, bore some resemblance, as Brizi pointed out, to a similar rot recorded from New Jersey, U.S.A., by Halsted in 1892. The American organism was not described in Halsted's account of the disease.

The more important works dealing generally with fungous diseases of plants, if they mention the celery at all in this connection, supply only brief references to the work of Halsted and Brizi, as in Sorauer's *Handbuch* (13) and in a recent volume by Ferraris (3).

Outbreaks similar to those mentioned above have been observed in other countries as shown by Ritzema-Bos (10), who in 1905 isolated a bacterium from celery and reproduced the rot by inoculation but did not describe the organism, and by Johnson and Adams (8) who noticed in celery "a brownish-rot similar to that of cabbage" in Ireland in 1910.

Professor Priestley,* of the University, Leeds, informs me that a celery-rot was observed in October, 1910, near Bristol. Apart from this I have not been able to obtain any evidence that the disease has been met with in this country except in the two instances mentioned below, which, however, together with the records from Bristol and Ireland, suggest that the rot may be fairly wide-spread.

A short time ago a gardener at Guildford, Surrey, to whom a diseased specimen from Wye had been shown, stated that

* Formerly of Bristol University.

he had lost a whole row (thirty yards long) and that the plants became "a sort of jelly" as he aptly expressed it. This jelly-like appearance is quite typical of the bacterial rot.

The *Gardeners' Chronicle* for October 18th, 1913, recorded that celery affected by bacteriosis had been sent in by a correspondent. The editors kindly put me in communication with the grower, who gives me this information: "Our celery was attacked in September; at first a few blotches were noticed, and then in one day the whole plant rotted down to the earth. Our man had to dig up and burn some and the rest he cut off; this eventually grew again a little, and we were able to use it. As far as I can hear, all this neighbourhood (Writtle, Essex) has been attacked in the same way." In this case, the early appearance (*i.e.*, September) of the disease is remarkable. The outbreak observed by Professor Priestley in Gloucestershire was also early in the season, while at Wye it has not been noticed before February 1st, on which date the first diseased specimen was examined in 1913.

The material that has come under my own personal observations has all been obtained from the College gardens at Wye. In some of those plants the outer leaves* only were attacked and for culinary purposes such samples suffered little or no depreciation in value; in the majority, however, the inner leaves were in a more or less advanced stage of decay, and at least some portions of these had to be removed, whilst in others all the inner leaves were destroyed and the rot had extended into the stem itself, destroying this from above downwards. In a few cases leaf-stalks which appeared normal on the surface showed, on being split longitudinally, discoloured internal tissue swarming with bacteria. Diseased plants often showed wounds caused by snails or slugs, and the inner surface of many of the petioles was transversely wrinkled; this latter condition is not always accompanied by a bacterial rot, though it seems to favour the development of the organisms since they are frequently to be found beneath the ridges. Eelworms were sometimes found in considerable numbers in the decaying parts, and it is probable that they, as well as snails and slugs, aid in disseminating the bacteria.

* "The outer leaves" are here understood to be those which even in normal plants would be discarded and stripped off before "the inner leaves" are prepared for the table.

The disease appeared again in the College gardens on February 11th of the present year (1914), and in order to obtain some idea as to the amount of damage done it was arranged that as the plants were removed from the ground for use they should be brought into the laboratory so that the plants could be subjected to individual examination. From February 18th until March 22nd, 108 plants of the variety "Standard Bearer" were examined; the results are given below. The other varieties grown in the gardens had been lifted before February, and the disease had not been observed on those. The following points were considered:—

(1) Whether the plants showed merely a normal decay or whether they suffered from soft-rot;
(2) whether the rot occurred in the outer leaves only, on the inner leaves only, or on both;
(3) whether the attack was a slight or a serious one; a slight attack was taken as being one where from one to three only of the inner leaves showed the rot, and a serious attack as one in which there were more than three such leaves.

	On outer leaves only.	On inner leaves only.		On inner and outer.		Normal decay only.	Number of plants examined.
		slight.	serious.	slight.	serious.		
Feb. 18th ..	—	2	1*	—	—	—	3
,, 20th ..	—	2	—	—	—	—	2
,, 21st ..	2	3	1*	2	—	2	10
,, 23rd ..	1	2	1	4	—	—	8
,, 25th ..	3	2	—	2	—	1	8
,, 26th ..	—	2	—	2	1	—	5
,, 27th ..	—	—	1	3	—	—	4
,, 28th ..	—	1	1	3	3	—	8
Mar. 2nd ..	1	—	—	2	—	1	4
,, 3rd ..	2	2	—	2	—	—	6
,, 7th ..	—	—	1*	—	—	—	1
,, 10th ..	—	1	1	1	—	1	4
,, 12th ..	—	1	3†	—	—	1	5
,, 14th ..	1	1	—	4	—	2	8
,, 16th ..	1	1	1	1	1	1	6
,, 17th ..	—	1	2	—	—	—	3
,, 18th ..	1	3	1	—	—	2	7
,, 19th ..	1	1	1	—	1	4	8
,, 22nd ..	—	2	—	4	—	2	8
Totals ..	13	27	15	30	6	17	108

* The centre of each of these plants was almost destroyed.
† Two of these three were altogether useless.

From these figures it will be seen that out of 108 plants 78 (approximately 72 per cent.) had inner leaves affected, while 21 (about 19 per cent.) were almost, if not quite, worthless.

The pulpy, brown, diseased portions of these inner leaves were readily distinguished from the healthy tissues, the discolouration of the former contrasting strongly with the adjoining blanched parts as shown in Plate XIX. In the older outer leaves the difference was not so marked.

Celery is not usually stored for any great length of time in this country and, as a rule, only when there is the possibility of the ground becoming so frozen that plants cannot be lifted for some days, in which case a quantity sufficient to last several days is taken up and kept until required. Under these circumstances the figures in columns 2 and 4 (slight attacks) are not so formidable as at first sight they may appear, for if, as in this instance, such plants are used immediately, the greater part of each would be in good condition; if stored these plants would undoubtedly become destroyed in a very short time, judging from the rate of progress of the rot in those plants inoculated from pure cultures and from naturally infected specimens kept in the laboratory.

As an illustration of the procedure in isolating pathogenic and other bacteria, the "poured-plate" method adopted for isolating the celery organism is given below:—

A nutrient medium* consisting of 1.5 per cent. agar-agar in an extract prepared from celery stems or leaf-stalks was found to be suitable for rapidly obtaining cultures of the bacterium. About 10 cc. of this medium were poured while hot into each of a number of test-tubes, which were then plugged with cotton-wool and sterilized either by steaming at 100°c. for twenty minutes on each of three successive days (discontinuous sterilization), or by steaming under pressure (in an autoclave) at 115° c. for twenty minutes once only. Such tubes after cooling were stored until required. When suitable (rotting) celery material was obtained, three of these tubes were steamed to melt the agar and allowed to cool in a beaker

* The method of preparing this medium is given in detail as a footnote in the Journal of Agricultural Science, Vol. VI., Part 2, May, 1914, p. 212.

of warm water until the temperature of the beaker and its contents dropped to 44° c.* A small particle of the bacteria-containing pulp taken from near the junction of diseased and healthy tissue was placed in a drop of sterile water on a flamed slide; almost immediately innumerable bacteria diffused out into the water and a small drop was then transferred to tube No. 1 by means of a platinum wire loop which had previously been flamed and allowed to cool. A drop of the liquid from tube No. 1 was taken on the platinum wire and transferred to tube No. 2; similarly a drop from No. 2 was placed in No. 3. The contents of each tube, after being thus noculated, were poured into a sterile petri dish and allowed to cool until the agar had solidified in a layer covering the bottom of the dish, which was then placed in an incubator at 26°c. In this way the bacteria became separated from one another, and each by rapid division gave rise to a colony. An examination of the plates made at the end of twenty-four hours showed No. 1 to be densely crowded with very small colonies; in No. 2 the colonies were less numerous, while in No. 3 they were well separated from each other although the colonies themselves were larger than in the other two plates.

From one of the isolated colonies so obtained a tube culture was prepared by taking a small portion of a colony on a platinum wire and drawing the needle over the surface of agar in a test-tube. Such a tube culture, the product of a single bacterium, is consequently *pure* and may be used in preparing "sub-cultures" and in performing inoculation experiments.

An organism which was isolated in this way from diseased celery proved capable of reproducing the rot when inoculated into healthy celery plants. Preliminary experiments were made by inoculating fresh pieces of celery "heart" (see Plate XX., No. 2), while subsequent inoculations were made on living plants. Of the latter some were taken direct from the garden, and, after the outer leaves were stripped off, the remaining central portion (stem and inner leaves) of each with roots still attached was washed under the tap, then with sterilized water, and the roots placed in a beaker of water, the whole being

* Agar solidifies at about 42° c. and the "plating out" must be done while the agar is at a temperature above 42° c., but not so high as to kill the bacteria.

covered with a bell-jar to minimize infection from air-borne spores; other plants used in the experiments were grown in pots in ordinary soil.

The bacterium was introduced into the tissues by placing a small portion of a culture on the cut ends of the petioles or in wounds made on the inner surface of the petioles.

One of these plants used in the inoculation experiments is shown in Plate XXI.; it was kept in a fresh condition during the experiment by placing the roots in water. The two largest leaves appearing in the photograph were wounded on the inner side of the leaf-stalk, at about one inch below the insertion of the lowest pair of leaflets, by the removal (using a flamed scalpel) of a small portion of tissue towards the upper surface, leaving a wound about one-eighth of an inch in diameter (in imitation of those made by snails and slugs), and penetrating about half-way through the petiole. Bacteria, taken from a single colony of a poured plate culture twenty-four hours old, were placed in the wound made in the leaf on the left, while that on the right remained without further treatment after the wound had been made. On the following day (twenty-four hours after inoculation) the infected leaf showed a brown area 1.8 cm. long and 0.9 cm. broad round the wound, from which was oozing a drop of liquid swarming with actively moving bacteria; the control leaf was unchanged. After a further period of twenty-four hours the discolouration (indicating extent of the soft rot) had reached to the edge of the petiole on both sides so that there was a zone of rotten tissue across the whole width and in consequence of this that portion of the leaf above the zone collapsed. This stage is shown in the photograph, the control remaining still unchanged. A fortnight later the rot had extended to the base of the inoculated leaf and was encroaching on the rest of the plant.

The plants growing in pots were also inoculated on the petioles, but in these cases the bacteria were placed on the inner surface and pricks were then made with a sterile needle through the bacterial mass. At first several pricks were made in each petiole to ensure a successful contact between the bacteria and the internal cells, but later it was found that a *single prick* made through a mass of bacteria taken from a young culture was sufficient to start the rot. In one

experiment, using a plant growing in soil, two petioles were inoculated by means of a single prick with a needle, with the result that on the third morning after the inoculation was made it was found that one of them had collapsed during the night, and that the rot had extended to 1 cm. above and 3 cm. below the point where the bacteria had been introduced; a few hours later the second leaf also collapsed and in this instance the limits of the rot were 1 cm. above and 2 cm. below the point of inoculation.

Whether the disease is contagious in the case of uninjured plants has not yet been definitely determined. In one experiment, however, it was noticed that where diseased leaves had collapsed and fallen across healthy ones the latter acquired the rot, which commenced in the neighbourhood of the spots where the remains of the decayed leaves had lodged. It is conceivable that the weight of the decaying mass might, in some instances, fracture the stalks of the leaflets and so permit the bacteria to enter through the wounds, the celery plant, particularly the young leaves, being very brittle.

Inoculation experiments performed last year (1913) on seedling celery plants a few inches high were only partially successful, and similar experiments are being carried out this year.

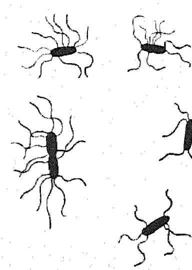
The organism, identified as described below, has been re-isolated from tissue which have become diseased after artificial infection with a pure culture, thus substantiating the evidence (already obtained by reserving, at the time the inoculations were made, corresponding controls* which did not contract the rot) which shows that the organism introduced into the plant was the one which produced the symptoms of the disease.

The bacteria parasitic in plant tissues are, with very few exceptions, to be referred to two genera comprising those rod-shaped forms which under favourable circumstances exhibit motility when in liquids; the movements are performed by means of wavy-bent processes of the protoplasm. These whip-like processes, or *flagella*, in the two genera are either scattered over the whole surface of the bacterium (genus

* The "controls" were plants, or petioles of the same plant, which were wounded like those inoculated, but bacteria were not applied to the wounds.

Bacillus Cohn) or are situated only at one "pole" (genus *Pseudomonas* Migula). The presence and arrangement of the flagella can be demonstrated only by special methods of staining, which usually involve the use of a "mordant." The figure shown on this page was drawn from a preparation stained by what is known as "Moore's Pitfield" method.

The species within the genus are, as a rule, indistinguishable morphologically, for bacteria, being unicellular organisms, do not possess "organs" or other characteristic features (except flagella) which might furnish means for description; size and shape are by no means constant, but often vary considerably even in cultures derived from the same individual. Identification therefore depends chiefly on their physical reactions, that is their behaviour under varying external factors as changes in nutrition, in temperature, etc. Their cultural relations are of primary importance and every species investigated must be cultivated on various recognized media before an adequate description of the organism can be obtained.



Bacillus apiovorus × 1,200.

Innumerable culture media, some of which are of general application, others that are used for special purposes, have been devised and new formulæ are still being published. Until a few years ago there was no defined system for the employment of these media and it was often difficult to obtain comparative results.

In recent years bacteriologists, particularly in America, have endeavoured to obviate this difficulty by introducing a basis of classification by means of which "the salient features of an organism belonging to any one genus can be conveniently expressed by a series of digits, representing a whole member and a decimal."* The system has been elaborated by the Society of American Bacteriologists and a description of it is given in a bulletin by Harding (6) published 1910. The method has been adopted by Dr. Erwin F. Smith (12) who is

* Quotation from the "Preliminary Report of the Committee on Methods for Identification of Bacterial Species," prepared for the Society of American Bacteriologists.

probably the greatest present-day authority on bacteriosis in plants and is used by him in his monograph on that subject three volumes of which have already appeared.

The "Numerical System of Recording the Salient Characters of an Organism" is as follows:—

100.	Endospores produced.
200.	Endospores not produced.
10.	Aërobic (strict).
20.	Facultative anaërobic.
30.	Anaërobic (strict).
1.	Gelatin liquefied.
2.	Gelatin not liquefied.
0.1	Acid and gas from dextrose.
0.2	Acid without gas from dextrose.
0.3	No acid from dextrose.
0.4	No growth with dextrose.
.01	Acid and gas from lactose.
.02	Acid without gas from lactose.
.03	No acid from lactose.
.04	No growth with lactose.
.001	Acid and gas from saccharose.
.002	Acid without gas from saccharose.
.003	No acid from saccharose.
.004	No growth with saccharose.
.0001	Nitrates reduced with evolution of gas.
.0002	Nitrates not reduced.
.0003	Nitrates reduced without gas formation.
.00001	Fluorescent.
.00002	Violet chromogens.
.00003	Blue chromogens.
.00004	Green chromogens.
.00005	Yellow chromogens.
.00006	Orange chromogens.
.00007	Red chromogens.
.00008	Brown chromogens.
.00009	Pink chromogens.
.00000	Non-chromogenic.
.000001	Diastasic action on potato starch (strong).
.000002	Diastasic action on potato starch (feeble).
.000003	Diastasic action on potato starch (absent).
.0000001	Acid and gas from glycerin.
.0000002	Acid without gas from glycerin.
.0000003	No acid from glycerin.
.0000004	No growth with glycerin.

When the organism isolated from celery had been shown, by the experiments to which reference has already been made, to be pathogenic to living celery plants, it was decided to obtain a description of it in accordance with the above scheme. It proved to be a *Bacillus*, motile by means of from two to twelve flagella. When obtained from the celery pulp or from young cultures (twenty-four hours old), the rods measure $2.5 - 3.5 \times 0.6-0.7\mu$ if occurring singly. Sometimes double rods (dimensions $5-6.5 \times 0.6-0.7\mu$) are met with, *i.e.*, two rods joined end to end and formed by the transverse fission of a single one the two individuals not having separated from each other; less frequently rods representing four bacteria are found.

Endospores have not been observed. The organism is aërobic, that is, it prefers to live in contact with air, but it is not strictly so, since it will grow readily in the closed end of a fermentation tube filled with a suitable nutritive liquid (facultative anaërobe). Gelatin (ten per cent. in beef bouillon)* is quickly liquefied; the culture shown in Plate XXII., Nos. 2 and 3, was obtained by making a *stab* with an inoculated platinum needle in the gelatin contained in the tube. As the bacteria began to multiply they induced a liquefaction of that medium, an early stage of the process being shown in the first of the two photographs and the completion in the second.

The dextrose solution consisted of :—

Peptone	2 gm.
Dextrose	1 gm.
Distilled water	95 cc.
Litmus (neutral) solution	5 cc.

By substituting lactose and saccharose respectively in place of the dextrose the media containing those sugars were prepared similarly. The solutions were poured into Durham's tubes† (15 cc. in each) and steamed for twenty minutes on

* Nutrient bouillon, a medium very frequently used for bacterial cultures, is a meat extract preferably prepared from fresh lean beef.

† A Durham's tube consists of a test-tube with a smaller tube, mouth downwards, placed inside; the intermittent steaming removes the air from the smaller tube, which consequently becomes filled with the liquid; on inoculation with a gas-producing organism bubbles of gas accumulate at the upper (closed) end of the smaller tube.

each of three successive days. Tubes were inoculated and incubated at a temperature of 26° c.; after twenty-four hours the solutions had become turbid and the original neutral tint of the liquid showed a reddening which was quite distinct in the tubes containing dextrose and saccharose, less so in those with lactose, though after a further period of twenty-four hours the red tint (indicative of acid formation) was equally evident in all three. Small bubbles of gas began to appear about this time, but gas production was never very copious and usually ceased after about two days. Control tubes, incubated at the same time, but not inoculated, showed no change whatever to the end of the experiment. The same three media were used for cultures in fermentation tubes, and the results, *i.e.*, turbidity, colour changes, and gas production, were similar to those in Durham's tubes.

The action on nitrates was studied by preparing tubes of a 0.5 per cent solution of potassium nitrate in nutrient bouillon. Ordinary tubes and Durham's tubes were used and inoculation made but no gas could ever be detected in the latter. After a few days, tests for nitrites were applied with very distinct positive results (negative results with the controls.) The result shows that potassium nitrate, in a nutrient medium inoculated with the bacillus, is reduced to nitrite without the evolution of gas.

Most of the cultures have a faint yellow tint but the colour is much more pronounced when sterilized potato is used as the nutrient medium.

Diastasic action on potato starch is estimated in accordance with the reactions given by the potato after the bacillus has been growing on it for some time and those given by inoculated tubes of starch jelly. The latter medium was prepared by rubbing up potato starch in Uschinsky's solution, modified and recommended for this purpose by Dr. Smith.* The results obtained indicated that the organism has but a very feeble action on the starch, no trace of sugar being found in any of these cultures, although a purplish reaction with iodine suggested the change of some of the starch to dextrin.

Glycerin cultures were obtained in Uschinsky's solution

* Bacteria in Relation to Plant Disease. Vol. I., p. 196.

containing four per cent. glycerin according to the following formula :—

Glycerin	40 cc.
Sodium chloride	6.0 gm.
Calcium chloride	0.1 gm.
Magnesium sulphate	0.4 gm.
Dipotassium phosphate	2.0 gm.
Ammonium lactate	6.0 gm.
Sodium asparaginate	4.0 gm.
Distilled water	One litre.

Ordinary tubes and Durham's tubes were used ; no gas was produced in the latter and tests were made for acid production but with negative results even in cultures fifteen days old, although a turbidity, resulting eventually in a dense sediment, showed that vigorous growth had occurred in the tubes. Control tubes remained quite clear. The inference is that in a suitable medium containing glycerin the organism is able to thrive but cannot convert the glycerin into acid.

After these cultural characters had been determined the organism was inoculated into a living plant, and when the rot had become established the bacterium was re-isolated. The new strain also proved to be a *Bacillus*, and in pure cultures gave results similar to those set out above, thus indicating that the two strains were identical. The conclusion to be drawn is that the organism with the characters set out in the following table and arranged according to the scheme set out on p. 467 is parasitic in celery plants and produces a soft rot :—

Endospores not produced	200.
Facultative anaërobic	20.
Gelatin liquefied	1.
Acid and gas from dextrose	0.1
Acid and gas from lactose	.01
Acid and gas from saccharose	.001
Nitrates reduced without gas formation	.0003
Yellow chromogens	.00005
Distasic action of potato starch (feeble)	.000002
No acid from glycerin	.0000003

The group number of this *Bacillus* thus becomes 221.1113523.

A more detailed account of the cultural reactions and of the inoculation experiments performed on celery may be seen in a paper by the writer (14) appearing in the *Journal of Agricultural Science*, May, 1914.

The organism appears to be one that has not previously been described and it is proposed therefore to name it *Bacillus apiovorus*. It seems clear that it is not the form described by Brizi for he states emphatically that his bacterium does not liquefy gelatin, while *Bacillus apiovorus* induces liquefaction very readily. On the other hand, the group number of the latter approaches that obtained for *Bacillus carotovorus* Jones, described and named by Jones (9) in 1901, and more recently investigated by Harding and Morse (7). The form number of *Bacillus carotovorus*, which also causes a soft-rot and is very destructive to carrots and other vegetables, is 221.1113022; a reference to the table on p. 467 will show that it is a white organism (*i.e.* non-chromogenic) which produces an acid in a glycerin-containing medium. Since the earlier cultural experiments were performed the absence of acid production from glycerin in the case of the *Bacillus* isolated at Wye has been confirmed by cultures and tests carried out in collaboration with the Chemical Research Department at this College.

Harding and Morse point out in their paper that there is a group of closely related forms (of which *Bacillus carotovorus* may be taken as the type) that produce soft-rot in vegetables, and *Bacillus apiovorus* must be included in that group.

It is probable that several bacteria are concerned in producing bacteriosis in celery. In addition to the *Bacillus* described above, a *Pseudomonas* with 1-3 flagella at one pole has been isolated and reproduced the symptoms of the rot on being placed on fresh slices of celery "heart," but so far as experiments have gone it is not certain that it can attack growing plants. Then, again, there is the form *Bacillus Apii* obtained by Brizi in Italy, but which has not yet been reported from this country.

Professor Saccardo informs us that bacterial rot of celery has again been prevalent in Italy during the past season, and Dr. M. T. Cook, the Plant Pathologist at the New Jersey Agricultural Experiment Station, writes to the effect that it has recently re-appeared near that station. The disease has been

noticed, as shown in this paper, not only in Kent, but in Essex, Gloucestershire, probably Surrey, and in counties Derry and Tyrone, Ireland. Although the available evidence does not show that the celery soft-rot is responsible for any considerable loss in this country, the observations made by Halsted in America and Brizi in Italy indicate that bacteria may seriously injure the celery crop, and growers are advised to take precautionary measures if symptoms denoting a bacterial rot come under their notice.

The only treatment that can at present be recommended is the destruction of diseased plants by burning to prevent inoculation of the soil; on no account should such plants be thrown on the manure heap, for the bacillus is able to live saprophytically some months and still retain its destructive properties. For the same reason, if the crop becomes infected, celery should not be grown on the same plot in the succeeding season.

Any measures taken to prevent attacks by snail, slugs, eelworms, and biting insects will tend to check the spread of the disease.

In conclusion the writer desires to thank Dr. Eyre and Mr. E. A. Fisher, B.A., of the Chemical Research Department at this College, for help and advice when the chemical reactions of the cultures were being investigated, and Mr. Chapelow for providing potted plants for the experiments.

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WILTING OF RASPBERRY AND LOGANBERRY CANES.

By H. Wormald, A.R.C.Sc., D.I.C., B.Sc.

Samples of Loganberry and Raspberry canes showing premature wilting have been sent in to the College from time to time during the past two years. The canes were almost invariably grey in colour over small areas in some cases, in others over almost the whole surface, and these grey areas were dotted with fructifications of various microscopic fungi. As the diseased areas are at first quite localized, and since each of them bears as a rule but one of the species here described, with the exception mentioned below, it appears probable that some if not all of these forms are parasitic and directly responsible for the wilting.

At least four forms of fungus-fructifications have been found in the wilted canes that have come under observation:—

Hendersonia rubi, Westendorp, has been found on both Loganberry and Raspberry canes. The fruit bodies (pycnidia) to the naked eye appear as minute dots, but with a hand lens they are seen to be elliptical (see Plate XXIII., No. 2), the elongation being in a direction parallel with the axis of the shoot; in this they are to be distinguished from the forms described below, which are always circular, or practically so, in surface view when examined with a lens. The reproductive bodies, or conidia, produced within the fructifications are brown in colour and transversely divided into several cells, usually four, of which the terminal ones are rather smaller than those towards the middle, and there is a slight constriction at each septum. Typical conidia measure $16—18 \times 7—8\mu$. When placed in water germ tubes grow out readily from the larger central cells; later the terminal cells may also give rise to

germ tubes (see fig. 1). This fungus has been described as a parasite on Raspberry and Loganberry canes,* and as preventive measures, spraying the young shoots with Bordeaux Mixture is recommended.

A second form, and one that has been of more frequent occurrence on the material examined than the *Hendersonia*

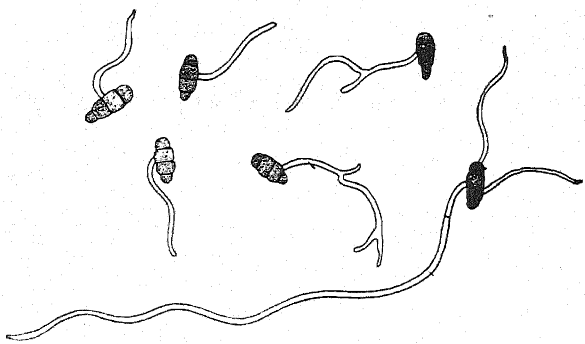


Fig. 1.
Germinating conidia of *Hendersonia rubi* × 500.

just described, is an ascomycete *Didymella applanata* (Niessl) Sacc. In this fungus the fruit-bodies (perithecia) are more or less flattened so that in taking a transverse section through the bark they appear elliptical (see Plate XXV., No. 1); in size they are usually about $175 \times 120\mu$, but may vary from $148 \times 110\mu$ to $216 \times 176\mu$, and each has a short beak which pierces the epidermis and communicates with the exterior.

The spores (*ascospores*) are produced in elongated sac-like cells (*asci*) growing from the base of each perithecium, and between the asci are delicate thread-like structures (*paraphyses*). The ascospores, of which there are eight in each ascus, are usually in two rows, and measure $14—19 \times 6—9\mu$†; they are two-celled with one cell (*i.e.*, that directed towards the apex of the ascus) a little broader than the other, slightly constricted at the septum dividing the two cells and are hyaline or lightly tinged with brown.

* See Leaflet No. 269 issued by the Board of Agriculture and Fisheries.

† In Saccardo's *Sylloge Fungorum*, the dimensions of the ascospores are given as $16 \times 5—6\mu$.

If at maturity the perithecia are moistened the asci elongate to about twice their previous length, and, projecting beyond the surface of the bark of the host plant, forcibly eject the spores in rapid succession. On one occasion this process was observed under the microscope. As each spore was thrown out the one next below it advanced in such a way that the larger of the two cells of the spore became situated at the apex of the ascus, where it remained for a very short time before it was itself thrown out, when the process was repeated until all the eight spores had been dispersed.

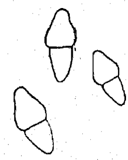


Fig. 2.
Ascospores of *Didymella applanata* × 500.

Frequently associated with *Didymella applanata* but sometimes found alone is a fungus, the fructifications of which, when merely examined with a hand lens, resemble the last-named form. The spores (*conidia*) are not, however, produced in asci, but are borne simply on short stalks (*conidiophores*), which form a layer (*the hymenial layer*) lining the inner wall of the fructification; this hymenial layer, together with the wall of the fructification itself, is sometimes folded inwards as shown in Plate XXV., No. 4. The conidia are minute ($2—3{\cdot}5 \times 3{\cdot}5—7\mu$) and almost colourless. The fungus conforms with the description given of *Coniothyrium Fuckelii* Sacc., which has been described as producing a Raspberry Cane Blight in America where inoculations with pure cultures have proved the fungus to be parasitic and capable of producing the cane blight. The following quotations taken from Duggar's "Fungous Diseases of Plants" show the conclusions that the American workers have arrived at.

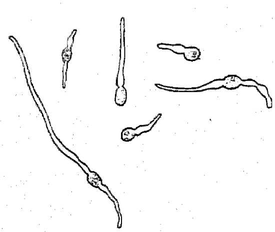


Fig. 3.
Germinating conidia of *Coniothyrium Fuckelii* × 500.

"The whole cane may be involved or only a portion of it. Often a single branch is killed while the remainder of the cane continues alive and apparently normal. In the majority of cases only a part of the cane dies. . .

"Clinton thinks that the raspberry cane blight fungus gains entrance through the flowers and young fruit, the spores apparently being spread by bees and other insects."

Coniothyrium Fuckelii is also parasitic on both wild and cultivated roses, producing on the stems, large, irregular cankers.*

This fungus is said to be the "imperfect" stage of the ascomycete *Leptosphaeria Coniothyrium* (Fuck.); the latter, though frequently found on dead twigs of species of *Rubus*† has not been observed on material examined at this College. As already stated the *Coniothyrium* is often found associated with the *Didymella*, and particularly have the two been found together on the old bases of the leaves, but whether there is any genetic connection between the two forms is a point that has not yet been investigated.

The three fungi above described have all been found on dead patches of bark on shoots which were still alive, as was shown by the fact that the leaves and flowering shoots both above and below the dead patches were, in many cases, still green, as may be seen in Plate XXIV.

Another form has been met with on a Loganberry cane, and though in this instance the cane was dead, the fungus appears to be identical with one that has been shown to be parasitic on one of the American blackberries, *Rubus nigrobaccus*, so it was thought advisable to give a description of the fungus here. Edgerton, who worked on the parasite in America, writes‡ :—

"It was not until the fruit was a little over half grown that the effect of the disease was noticed. Very suddenly, the leaves and the fruit above the spots wilted and dried up. The effect on the plant seemed to be that of girdling. The appearance of the canes was very similar to the cane blight of raspberries caused by a species of *Coniothyrium*. . . . The spots at this time were very evident, being two to five inches in length and completely encircling the stems, somewhat lighter in colour than the healthy regions and possessing a dry, dead appearance.

* *Journal*, Roy. Hort. Soc. Vol. XXXIV. p. 222.

† The genus includes the Raspberry, Loganberry and Blackberry.

‡ "Notes on a parasitic *Gnomonia*." Bull. Torrey Bot. Club, Vol. XXXIV. (1907), p. 593-597.

"An examination of the spots showed the presence of numerous black perithecial beaks, which appeared to the naked eye as small black setae, protruding through the dead cortex."

The same writer determined the microscopic character of the fungus, which proved to be *Gnomonia Rubi* Rehm, to be as follows :—

"The perithecia are subglobose, 200—260 × 175—220μ filled with the numerous asci. The asci are long-clavate 20—50 × 6—9μ and contain as a rule but four spores. . . . The spores are in one or two series, filling nearly the whole ascus about 14—19 × 3—5μ. They are two-celled, the two cells being equal, constricted at the septum, somewhat fusoid, quite often guttulate.* Each end of the spore is continued into a long hyaline point, but this falls away very readily so that the end of the spore has a rounded appearance. Paraphyses are absent."

The form found on the Loganberry conforms with this description of *Gnomonia Rubi* except that the ascospores are rather smaller (12 × 3μ) and the hyaline appendages have not been observed, but it is possible that the specimens examined at Wye were not quite mature.

Edgerton was able to reproduce the disease by inoculations from pure cultures and writes in conclusion :—

"The results of this study seem to show that the fungus *Gnomonia Rubi* Rehm is a weak facultative parasite, a form that will grow rapidly as a saprophyte on the dead canes and will, if conditions are suitable, adapt itself to the living cane. It does not seem probable that it is a form that is liable to become a serious pest to blackberry canes, but rather one that may appear as a parasite only occasionally, only when the conditions are right."

Up to the time of writing only one cane bearing the fructification as described by Edgerton has come under our observation, and we have no evidence that the fungus is truly parasitic on either Loganberry or Raspberry canes in this country, but from the fact that the fungus is capable of producing a wilt on a closely allied host plant, growers are advised to examine wilted canes in order to ascertain whether

* *i.e.*, containing globules of oil.

this or any other fungus of known or suspected parasitic habits is present. *Gnomonia Rubi* is easily distinguished from the fungi already mentioned because of the beaked perithecia. If a portion of a cane bearing the fructifications be held up to the light and examined with a hand lens the beaks are seen projecting beyond the bark, appearing like small, black, scattered warts.

During the season of 1912 Loganberry shoots were noticed which showed elongated pale grey patches of bark, often several inches in length, dotted over with minute black specks which usually were not so sharply defined, when seen either with the naked eye or with a lens, as the fruit bodies of the forms mentioned above. Transverse sections made through the bark and examined with the microscope showed the black dots to be stroma-like tufts of fungal hyphæ which had burst through the epidermis; two of these are shown in Plate XXV., No. 2. No conidia have up to the present been observed on these stromata, and although an examination was made in the same plantation in 1913 this fungus was not found and its systematic position has not been determined.

The fungus *Ascochyta pallor* which is said to be parasitic on species of *Rubus* has not been observed on any of the material examined at Wye.

The first signs of the wilt disease as shown by the Loganberry may be seen on the young canes as early as July, when discoloured areas appear on the bark. These become more defined during August and September, but fructifications were not detected before October. The photograph on Plate XXIII., No. 1, shows a canker-like area with light grey, almost white bark, on a Loganberry cane, obtained on October 14th, 1913; the fructifications showing as black dots were found to be of the *Coniothyrium* type, as described on page 476. The fungus had invaded not only the cortex (bark) but also the wood and the pith, as shown by the browning (see Plate XXIII., No. 3) and by the presence of hyphæ in the vessels and cells of those tissues.

The discoloured patches of bark assume a greyish colour and may reach a considerable length, extending in a direction parallel with the axis of the shoot for some inches. In the case of the Loganberry the diseased canes often persist through

the flowering season but their development is retarded and the fruit either does not ripen or reaches maturity after the rest of the crop has been picked. The first three forms mentioned are to be found from October onwards until the canes are removed after fruiting, and spores capable of germination are to be obtained throughout the winter and spring.

As the mycelium of the various fungi is within the tissue of the host plant, in the bark or even in the wood and pith, spraying with fungicides is futile as a *remedy* when once the mycelium has gained an entrance. In one case that came under our notice, diseased Loganberry canes showing fructifications of *Hendersonia rubi* and *Coniothyrium Fuckelii* had been winter-sprayed with lime-sulphur wash and portions of these sprayed shoots, with the dry wash still on them, were subsequently sent in to the College (January, 1913) that the viability of the spores might be tested. Spores of both fungi were found and they were apparently uninjured, but the convincing proof that they were still alive lay in their power of germination when set up in hanging drops. Both kinds of spores germinated readily, proving not only that living spores, capable of producing germ tubes, are produced during the winter months, but also that they remained uninjured by the spray. Figs. 1 and 3 were drawn from hanging drops containing conidia obtained from fructifications on the sprayed canes.

Spraying experiments with lime-sulphur wash as a *preventive* during the growth of the canes were performed during the summer of 1913, but no definite conclusions regarding the value of the spray against this disease have yet been reached. It was shown, however, that the lime-sulphur wash at ordinary summer strength (1.01 S.G.) may be used on Loganberry bushes without risk of spray injury.

It is advisable to remove and burn promptly all diseased canes immediately after the fruit has been picked.

Another form of raspberry cane wilt has come under our notice during the past year. In this case the whole of the lateral (flowering) shoots of one or more of the canes at the same root, become wilted and the leaves droop. Usually

this occurs early in the season ; such shoots may fail soon after they begin to elongate or they may reach the flowering stage before they show signs of withering. Diseased plants of this type were first sent to the College on June 5th, 1913, and between that date and July 7th, similar material was received from three widely separated plantations in Kent and Surrey.

Some of the canes showed the fructifications of *Didymella applanata,* while others were apparently quite free from fungi on the canes themselves although an examination o the roots revealed almost invariably, at the crown of the plant, the presence of white fungous outgrowths bearing numerous sickle-shaped spores (conidia) of the type referred to the genus *Fusarium.* This form was sometimes to be seen on exposing the roots as the plants were lifted from the soil, in others it appeared in from two to five days, provided that the roots were kept in a damp atmosphere, *e.g.*, by placing them on damp blotting paper in a large petri dish.

The conidia of this fungus are abstricted from the white pustules (*sporodochia*) which are to be found bursting through the cortex of the roots a few inches below the ground level, and sometimes on the bases of the canes themselves. From one root conidia were obtained from a pustule situated seven inches below the base of the canes.

The dimensions of the conidia are typically about $36 \times 6\mu$, but the length may vary from $32\text{-}40\mu$. Each conidium has, as a rule, two septa, dividing it traversely into three cells ; the septa are rather inconspicuous, but the divisions are usually indicated by a highly refractive globule which may be seen at or near the centre of each cell (see Fig. 4). A typical conidium is somewhat attenuated towards one extremity (indicating the point of attachment before its abstriction), the cell there being rather longer and narrower than the other cells of the conidium. Only rarely were three septa to be seen, while the smaller conidia had often but one septum each.

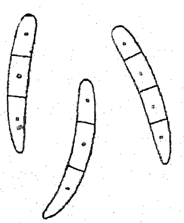


Fig. 4.
Conidia of a *Fusarium* obtained from diseased Raspberry roots × 500.

A *Fusarium,* suspected of being parasitic on the Raspberry, but which, in inoculation experiments has given only

negative results, was observed on the roots of dying Raspberry plants in Switzerland during the summer of 1911, and described by Osterwalder.* It is considered to be the conidial stage of an ascomycete, *Nectria Rubi*, which was also found on the roots of the diseased Raspberries.

The conidia (as obtained from the diseased roots) of the *Fusarium* described by Osterwalder are similar in general shape to those obtained from the form growing on the Raspberry roots obtained from Kent and Surrey; they are, however, generally larger (42.5—61.2×6.6—7.9μ),* they usually have three septa, and are borne on violet-coloured pustules.

The wilting of Raspberry and Loganberry canes appears to be fairly distributed throughout the country as is shown below :—

Loganberry canes with *Didymella applanata* and *Coniothyrium Fuckelii* have been received from Maidstone, Kent, from Woodnesborough, Kent, and from Worcestershire; with *Hendersonia rubi* from near Maidstone.

Raspberry canes bearing *Didymella applanata* and *Coniothyrium Fuckelii* have been sent in from Blairgowrie, N.B. (in 1911), with *Hendersonia* from Bramley, Surrey.

Gnomonia rubi has been found up to the time of writing only on a Loganberry cane obtained from near Maidstone.

The *Fusarium* has been obtained on the roots of Raspberries from Woodnesborough, Kent, from Warlingham, Surrey, and from Bramley, Surrey.

* *Osterwalder, A.*, "Über eine neue auf kranken Himbeerwurzeln vorkommende Nectria und die dazu gehörige Fusarium-Generation." (Berichte Deutsch. Botan. Gesellsch. Band XXIX., pp. 611-622. Berlin, 1911.)

NOTE ON *RHIZOPUS NIGRICANS.*

By H. Wormald, A.R.C.Sc., D.I.C., B.Sc.

An article on "The *Rhizopus*-rot of Tomatoes" appeared in the last number of this *Journal*, and there it was proved that *Rhizopus nigricans* is capable of rapidly producing a soft rot of the internal tissues of the tomato fruit on gaining entrance through wounds in the skin. In that article it was stated that this fungus produces thick-walled resting spores (zygospores) which are formed only when two strains, the (+) and the (—) forms are growing together. The following statement also appeared*: "No zygospores have yet been found on the material at Wye, and since all the cultures were derived originally from a small portion of mycelium obtained from a diseased tomato it is to be presumed that they are all of one strain, but whether (+) or (—) has not yet been ascertained."

Since then tube cultures of the (+) and (—) strains have been obtained from the *Bureau pour la distribution de Cultures de Moisissures* at Amsterdam, for comparison with the Wye strain. Another unknown strain was received from South Kensington; this was kindly sent by Mr. C. West, who obtained the strain by exposing a piece of bread in a laboratory at the Royal College of Science, and prepared a tube culture from the resulting growth.

The four strains (*i.e.*, the named (+) and (—) strains from Amsterdam, the South Kensington strain and the original one used in the inoculation experiments described in the last number of this *Journal*) were simultaneously inoculated into tomatoes, all of which soon acquired the characteristic rot, thus proving that all four strains of the fungus were equally capable of producing the rot.

These strains were then employed in the following experiments, which were carried out in an endeavour to induce the development of zygospores.

* Vol. XXI., p. 390.

Nutrient agar, prepared from an extract of prunes, was poured while hot into four sterilized petri dishes and allowed to cool. In this way a thin layer of the jelly-like agar was obtained in each dish. The dishes were numbered and spores from two strains of *Rhizopus nigricans* were placed in each. The method of inoculation was as follows :—

A flamed platinum loop was dipped in sterilized water and the small drop of water retained in the loop was brought in contact with one or more sporangia of the culture. The water caused the rupture of the sporangia; the spores were thus liberated and received into the drop of water which was then transferred to the agar and placed about 2.5 cm. from the centre of the dish. After flaming the wire in order to destroy any spores still adhering to the loop, spores were obtained from a second culture in the same way, and placed in the same dish, but on the opposite side of the centre, so that the two groups of spores were approximately 5 cm. apart.

Dish No. 1 was inoculated from the (+) strain and from the (—) strain.

Dish No. 2 was inoculated from the Wye strain and from the (+) strain.

Dish No. 3 was inoculated from the Wye strain and from the (—) strain.

Dish No. 4 was inoculated from the Wye strain and from the strain obtained from South Kensington.

All four were placed in an incubator at a temperature of 26° C.

Within forty-two hours the spores had germinated and produced mycelium which in Dishes No. 1, 2 and 3 had reached the centre of the plates (*i.e.* 2.5 cm. from the point of inoculation in each case), and the two strains in each plate had, in consequence, come into contact with one another. In No. 4 growth had taken place less quickly, but even here the mycelium had reached to 1.5 cm. from the points of inoculation.

After sixty hours mature (black) sporangia were found in Nos. 1, 2, and 3, while in No. 4 the two mycelial masses had now come in contact in the centre of the plate; four hours later mature sporangia were found in the latter culture also, while in No. 2 the early stages of zygospore formation were to

be seen together with a few immature zygospores. Later zygospores were produced in Nos. 1 and 4, but not in No. 3.

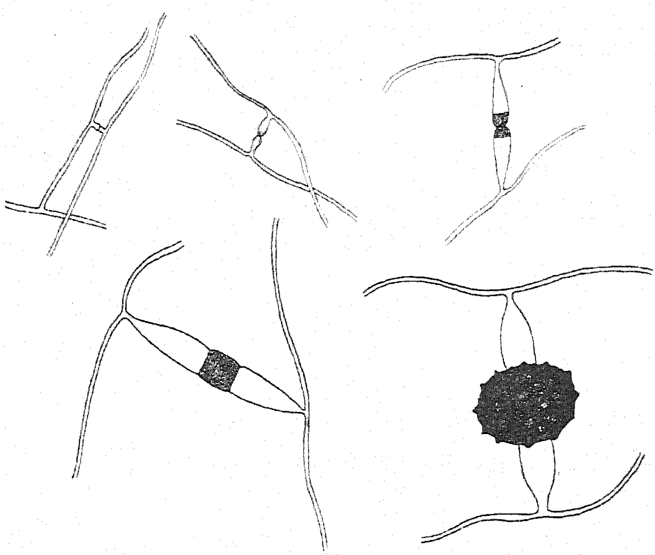
Thus zygospores were obtained by growing together

(*a*) the (+) strain and the (—) strain,

(*b*) the (+) strain and the Wye strain,

(*c*) the strain from South Kensington and the Wye strain

but no zygospores have been observed by growing together the Wye strain and the (—) strain.



Rhizopus nigricans. Stages in the development of zygospores × 100.

The conclusions to be drawn are: (1) the Wye strain is identical with the (—) strain, since it will conjugate with the (+) strain but not with the (—); (2) the strain obtained from South Kensington on the other hand is the (+) form since zygospores are produced by growing it with the Wye, *i.e.* (—), strain.

Some months later the experiments were repeated, using fresh cultures from the Amsterdam Centralstelle, and subcultures from the original Wye and South Kensington strains. The cultures on this occasion were kept at ordinary room temperature (about 16°C.) and in consequence growth was not

so rapid as in the previous experiments. Zygospores in various stages of development were, however, produced within seven days, except (as before) where the Wye strain and the (—) strain were grown together.

The accompanying figure shows stages in zygospores development produced by the cultures obtained in the second set of experiments.

I wish to thank Mr. C. West, A.R.C.Sc., D.I.C., B.Sc., of the Imperial College of Science and Technology, for preparing and forwarding the original cultures of the South Kensington strain of *Rhizopus nigricans*.

THE COMPARATIVE SUSCEPTIBILITY OF VARIETIES OF SWEDES AND TURNIPS TO THE "SWEDE MILDEW"

(*Erysiphe polygoni* D.C.).

By G. O. SEARLE, B.Sc.

During the summer of 1913 a number of plots of Swedes, Turnips and Rape were grown to test the comparative susceptibility of various varieties to Swede Mildew (*Erysiphe polygoni* D.C.).

Samples of thirty-three varieties of Swedes, forty-two varieties of Turnips, and two varieties of Rape were obtained from five well-known seed merchants in England and Scotland.

The plots measured ten links square, *i.e.*, one-thousandth of an acre each, and each plot had five rows of plants, *i.e.*, two links apart with the space of one link between the outside row and the outside of the plot.

Owing, however, to limited space, twenty-six varieties were relegated to smaller plots, and were grown in single rows, each five yards long. In order to make the weights of these smaller plots roughly comparable with the fifty-one main plots, they have, in the following table of results, been multiplied by eleven-fifths, since a row of plants five yards long is five-elevenths of a plot ten links square, containing five rows. The varieties in these smaller plots were chiefly ones identical in name with others in the main plots, the only difference being that they came from different seedsmen.

The fifty-one main plots were arranged in three groups of seventeen plots each, running the length of the ground used, the rows of plants being continuous through each line of seventeen plots. Between each group ran a path two links

wide, and also between the outside group and the twenty-six smaller plots, the rows of which also ran up and down the length of the land.

As far as possible, the plots of Swedes, Turnips, and Rape were all mixed one with another in order to give all the plots the maximum opportunity of uniform infection. All the plots were sown by hand during the three days, June 9th, 10th and 12th.

Previously to this, viz., on May 12th and 23rd, plots of mixed seed, each approximately twenty-five square yards, had been sown to provide, if possible, material for carrying out the inoculations, as farmers commonly hold the theory that if Swedes and Turnips are sown earlier than the beginning of June the attack of mildew will be more certain and more severe.

However, the theory was found not to apply in the present case, as these two early plots did not become attacked earlier or more severely than the main crop of Swedes on the farm, from which finally the material for inoculation was obtained.

During the succeeding month or so the plots were thinned and cultivated in the usual way.

The mildew first appeared in the greenhouse on some Swedes in pots on July 23th, but there was not sufficient material to spare from the series of indoor inoculations, which were being carried on, to allow of the plots being inoculated then.

Finally, on August 23rd, the mildew appeared on the main crop of Swedes on the farm; on August 28th a large number of infected leaves were picked and brought into the laboratory, where they were placed in a warm, moist atmosphere to encourage the formation of a large number of conidia.

On August 29th these leaves were washed in large cans of water, after which the water was found to have quite a milky appearance from the large number of conidia it contained. This water was then sprayed as evenly as possible all over the plots with a fine rose.

The weather at the time was dull, but no rain fell for three or four days, so the conidia had ample time to germinate successfully and infect the leaves.

Before the inoculation was carried out a very careful

search for a natural infection was made, but no trace of mildew could be found on any plot. The mildew was first noted on the plots on September 2nd, when, after careful examination, a few minute patches of mildew were found to be present on very nearly every plot.

From September 6th onwards, the amount of mildew present was classified, once a week, in the following manner: Marks were assigned each week to each plot, these marks varying from 0-10 according to the severity of the attack; the plots marked 0 were those on which no traces of fungus could be found, and so on proportionately up to 10 assigned to the plots most severely attacked, and on which not a single leaf could be found free from mildew.

Although this method for the estimation of the amount of disease present was open to a certain amount of error, since it was based on the relative appearance of the plots as noted by the eye, it was found in practice, that it was comparatively simple to place any given plot in its proper class with only a very small error.

On October 9th the last estimate was made as the attack seemed by then to have attained its maximum severity; from that date onwards new leaves, as they were formed, were only slightly attacked and the plants grew well.

On November 3rd all the plots were pulled, the roots topped and cleaned, and then weighed in a basket on a spring balance. On an average the plots contained fifty roots each.

It will be noted from the following table that every plot was attacked to a certain extent, so that no variety could be marked as low as 0.

As will be seen, from the table given below, the Swedes were attacked more severely than the Turnips, though the latter were sometimes badly attacked, but do not show it to an equal extent, since the greatest growth of mildew is on the lower side of the leaf; this fact was taken into account in estimating the severity of attack.

To obtain, as far as possible, comparative results, all the varieties were sown and pulled at the same time; in consequence some of the softer and earlier varieties of turnips became over ripe and suffered more or less severely from

various kinds of rot; this caused an interference with the estimation of the crop, though it had no effect on the estimation of the disease, as the rotting did not occur till the last week or so before pulling and after the disease estimations had been finished.

In a letter from Messrs. Drummond & Sons, these seedsmen state that, in their experience in the North, the bronze top Swedes are more liable to mildew than the purple or green top varieties; also that purple top yellow is more susceptible than green top yellow, and that their Improved Bronze Top was the best in this respect.

From the table it will be seen that this Improved Bronze Top (No. 40) became the most severely attacked of all their sixteen samples. No. 11, a green top, proved very susceptible, but No. 14, also a green top, was only slightly attacked, whilst No. 31, Irvine's Disease Resisting Swede, quite belied its name.

In the following table are given, the number of the plot, origin of seed, name of variety, weight of crop in lbs., the marks estimating the severity of the attack, an average of these marks, and some general remarks including shape, and the varieties of Turnips attacked by rot.

It must be borne in mind that the results recorded are those of only one year, and of a year when Swedes generally were badly attacked by mildew in this district; the same varieties will again be grown in the same sized plots and under similar conditions this year. It will be best, therefore, to await the results of the 1914 trials before making an estimate of the comparative susceptibility of the different varieties.

PLOT RESULTS, 1913.

No. of Plot.	Name of Seedsman.	Variety.	Weight of Crop. (1/1000th acre.)	Severity of attack. Weekly figures (see p. 489).						Average of Weekly figures.	Remarks.
			lbs.	1st.	2nd.	3rd.	4th.	5th.	6th.		
		SWEDES.									
1	Sutton	Magnum Bonum Swede	58	4	2	2	4	5	4	3½	Tankard.
3	,,	Improved Lord Derby Swede ..	50	5	4	4	4	4	4	4⅙	Round.
8	,,	Up-to-date Swede	50	8	9	10	10	10	10	9½	Round.
9	,,	Champion Swede	57	8	7	7	7	9	9	7⅚	Round.
10	,,	Hardy White Swede	53	6	5	6	7	7	7	6⅓	Round.
11	,,	Green Top Swede	48	10	9	9	9	9	9	9⅙	Tankard.
12	,,	Queen Swede	53	10	9	9	8	9	9	9	Tankard.
13	,,	Crimson King Swede	55	4	4	4	5	8	9	5⅔	Tankard.
14	,,	Centenary Hybrid Green Top Swede	43	1	3	3	3	2	2	2⅓	Round—Flat.
24	Austin and McAslan	X-L All Swede	50	4	7	7	6	7	7	6⅓	Round.
25	,,	Best of All Swede	54	5	4	6	7	9	9	6⅔	Round.
26	,,	Elephant Swede	57	2	4	5	5	8	8	5⅓	Round.
27	,,	Webster's Swede	41	8	6	7	6	8	7	7	Round.
28	,,	Drummond's Swede	55	7	7	7	6	8	8	7⅙	Round.
29	,,	Austin's Eclipse Swede	52	6	5	7	5	7	6	6	Round.
30	,,	Austin's St. Mongo Swede	53	5	5	6	5	8	8	6⅙	Round.
31	,,	Irvine's Disease Resisting Swede ..	22	5	4	5	6	8	8	6	Round. Germination capacity seemed poor.
32	,,	Austin's Clydesdale Swede	41	7	5	6	6	7	7	6⅓	Round.
33	,,	Supreme Swede	35	4	4	4	5	6	5	4⅔	Round.
34	,,	Kangaroo Swede	46	4	5	5	6	8	9	6⅙	Round.
35	Drummond	Stirling Castle Swede	40	4	5	4	3	4	4	4	Tankard.
36	,,	Extra Improved Swede	43	7	6	6	6	6	6	6⅙	Tankard.
37	,,	Monarch Swede	48	3	6	5	6	6	7	5½	Tankard.
39	,,	New Cross 1908 (Purple Top Swede)	48	6	6	6	6	6	6	6	Tankard.
40	,,	Improved Bronze Top Swede ..	51	6	9	9	9	8	7	8	Round.
43	,,	New Cross, 1912 (Purple Top Swede	52	4	6	6	7	8	8	6½	Round.

No. of Plot.	Name of Seedsman.	Variety.	Weight of Crop. (1/100th acre.)	Severity of attack. Weekly figures (see p. 489).						Average of Weekly figures.	Remarks.
			lbs.	1st.	2nd.	3rd.	4th.	5th.	6th.		
44	Little and Ballantyne	Carlisle Castle Bronze Top Swede ..	50	7	9	7	8	8	9	8	Round.
47	,,	Knowefield Purple Top Swede ..	44	6	6	6	7	7	8	$6\frac{2}{3}$	Round.
48	,,	Lonsdale Green Top Swede	32	5	5	5	6	7	8	6	Round.
56	Austin and McAslan	Hardy Green Top Swede	61	5	5	4	5	6	7	$5\frac{1}{3}$	Round.
63	Drummond	Best of All Swede	57	2	3	4	3	7	9	$4\frac{2}{3}$	Round.
64	,,	Hardy Green Top Swede	44	7	7	8	6	6	9	$7\frac{1}{6}$	Round.
68	Little and Ballantyne	Monarch Purple Top Swede	40	2	2	4	4	7	8	$4\frac{1}{2}$	Long.
70	,,	Best of All Purple Top Swede ..	35	3	3	3	4	6	8	$4\frac{1}{2}$	Tankard.
		TURNIPS.									
2	Sutton	Long Keeper Aberdeen Turnip ..	42	0	1	2	4	5	4	$2\frac{2}{3}$	Round. Large proportion rotted.
4	,,	Perfection Green Top Aberdeen Turnip	30	1	1	1	1	1	1	1	Round. Large proportion rotted.
5	,,	Yellow Tankard Turnip	61	2	3	4	4	4	4	$3\frac{1}{2}$	Tankard.
6	,,	Selected Fosterton Turnip	59	2	3	4	5	4	3	$3\frac{1}{2}$	Flat. Some rotted.
7	,,	All-the-Year-Round Turnip	75	2	4	4	5	5	5	$4\frac{1}{6}$	Flat.
15	,,	Early Sheepfold Turnip	62	1	3	2	2	4	2	$2\frac{1}{3}$	Tankard.
16	,,	Early Six-Week Turnip	68	2	4	3	3	4	2	3	Flat.
17	,,	Pomeranian White Globe Turnip ..	88	2	4	4	4	6	5	$4\frac{1}{6}$	Round.
18	,,	Red Paragon Turnip	96	1	1	1	4	4	5	$2\frac{2}{3}$	Long.
19	,,	Greystone Turnip	81	1	2	2	4	4	5	3	Tankard
20	,,	Purple Top Mammoth Turnip ..	100	1	1	1	4	4	5	$2\frac{2}{3}$	Tankard. One or two rotted.
21	,,	Hardy Green Round Turnip ..	57	1	2	3	3	4	4	$2\frac{5}{6}$	Round.
22	,,	Imperial Green Globe Turnip ..	77	1	3	4	4	4	3	$3\frac{1}{6}$	Round. Some rotted.
38	Drummond	Stobo Blue Yellow Turnip	56	3	3	4	7	6	6	$4\frac{5}{6}$	Tankard. Some rotted.
41	,,	Purple Top Yellow Turnip	34	2	5	5	8	8	6	$5\frac{2}{3}$	Round. Most rotted.

42	Drummond	Improved Aberdeen Green Top Yellow Turnip.	50	2	4	4	6	6	6	$4\frac{2}{3}$	Round. Most rotted.
45	Little and Ballantyne	White Globe Turnip	72	4	6	5	8	7	7	$6\frac{1}{6}$	Round.
49	Carter	Re-selected Red Globe Turnip ..	78	2	3	2	4	4	4	$3\frac{1}{6}$	Round.
50	,,	Improved Purple Top Mammoth Turnip	71	1	2	1	2	3	2	$1\frac{5}{8}$	Round.
51	Carter	Improved Red Paragon Turnip ..	80	1	2	2	4	4	4	$2\frac{5}{6}$	Round.
52	Sutton	Favourite Purple Top Aberdeen Turnip	44	1	2	2	4	6	6	$3\frac{1}{2}$	Tankard. Some rotted.
53	,,	Purple Top Aberdeen Turnip	35	1	2	3	7	6	6	$4\frac{1}{6}$	Round. Large proportion rotted.
54	,,	Green Top Aberdeen Turnip	46	1	2	1	3	3	3	$2\frac{1}{6}$	Long. Some rotted.
55	Austin and McAslan	White Globe Turnip	58	1	2	2	4	5	4	3	Round. One or two rotted.
57	,,	Fosterton Hybrid Yellow Turnip ..	57	1	2	1	1	1	4	$1\frac{2}{3}$	Round.
58	,,	Aberdeen Green Top Yellow Turnip	51	1	1	1	1	1	1	1	Round.
59	,,	Mammoth Purple Top White Turnip	75	1	2	1	2	3	5	$2\frac{1}{3}$	Tankard.
60	Drummond	Purple Top Mammoth White Turnip	78	1	1	1	1	2	2	$1\frac{1}{3}$	Tankard.
61	,,	Improved Early Yellow Turnip ..	46	1	3	2	3	2	3	$2\frac{1}{3}$	Round. Some rotted.
62	,,	Fosterton Hybrid Yellow Turnip ..	44	1	2	3	4	4	5	$3\frac{1}{6}$	Round.
65	,,	Pomeranian White Globe Turnip ..	44	1	2	2	3	3	2	$2\frac{1}{6}$	Round. Some rotted.
66	,,	Green Globe Imperial White Turnip	106	2	2	1	3	2	2	2	Round. One rotted.
67	Little and Ballantyne	Fosterton Hybrid Yellow Turnip ..	40	1	1	1	1	2	2	$1\frac{1}{3}$	Round. Some rotted.
69	,,	Green Globe White Turnip	84	1	7	6	7	7	6	$5\frac{2}{3}$	Round.
71	,,	Purple Top Mammoth White Turnip	62	1	2	2	2	4	3	$2\frac{1}{3}$	Tankard.
72	,,	Aberdeen Green Top Yellow Turnip	31	2	3	2	3	2	3	$2\frac{1}{2}$	Round.
73	,,	Chieftain Green Top Yellow Turnip	88	2	2	1	2	2	3	2	Round.
74	Carter	Imperial Green Globe Turnip ..	95	2	2	1	2	3	2	2	Round. One rotted.
75	,,	Devonshire Greystone Turnip ..	106	1	2	1	3	5	4	$2\frac{2}{3}$	Flat.
76	,,	Pomeranian White Globe Turnip ..	101	2	5	6	6	6	6	$5\frac{1}{6}$	Round.
77	Austin and McAslan.	Purple Top Yellow Turnip ..	77	1	4	5	6	6	6	$4\frac{2}{3}$	Tankard.
		RAPE.									
23	Austin and McAslan	Broad Leaved Sowing Rape ..	—	4	4	5	4	8	8	$5\frac{1}{2}$	—
46	Little and Ballantyne	Broad Leaved Rape	—	8	8	7	7	8	9	$7\frac{5}{6}$	—

INFECTION-EXPERIMENTS WITH THE POTATO "BLIGHT" FUNGUS.

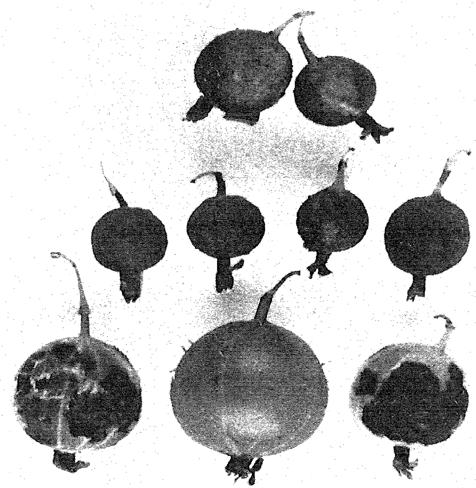
(*Phytophthora infestans*).

By G. Smith, B.Sc.

In his recently published book "Potato Diseases in Australia," Professor D. McAlpine states that *Phytophthora infestans*, lately introduced into Australia, has proved capable of infecting *Solanum aviculare*, a common Australian weed. It seemed of interest to ascertain whether the fungus as it occurs in this country would be able to infect at once *S. aviculare*, or whether it required a process of gradual adaptation. For inoculation experiments, healthy plants of *S. aviculare* were raised from seed (obtained from Vilmorin, of Paris), in a cool glass-house and these plants remained throughout the summer free from disease. In August, the blight appeared in the potato crop on the Farm; from this material suspensions of sporangia were obtained, and healthy potato leaves and potato slices were inoculated. The fungus developed rapidly and on both substrata produced sporangia in abundance and in a pure state. Plants of *S. aviculare* and potato leaves were inoculated in the evening with a suspension of sporangia, and were kept under bell-jars for twenty-four hours in order to give the sporangia favourable conditions for germination. Other plants were kept under similar conditions as controls. The potato leaves developed the disease and sporangia were produced in a few days, but *S. aviculare* was slower in developing the symptoms, and it was not until the twelfth day that sporangia were produced on the leaves. The control plants remained perfectly healthy. The experiment was repeated and the same results were obtained.

In text-books the common English weed *S. dulcamara* is given as a host-plant of *Phytophthora infestans*. It is obviously of economic importance in connection with the persistence

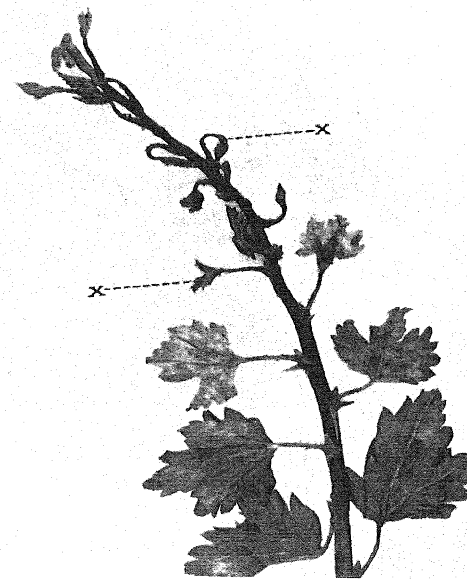
PLATE I.



[W. H. Hammond, photo.

Gooseberries (*Cousin's Seedling*) all except one attacked by the American Gooseberry-Mildew. The healthy berry shows the size to which the others should have grown if healthy. The smaller berries are completely invested with the brown mycelium.

PLATE II.



[W. H. Hammond, photo.

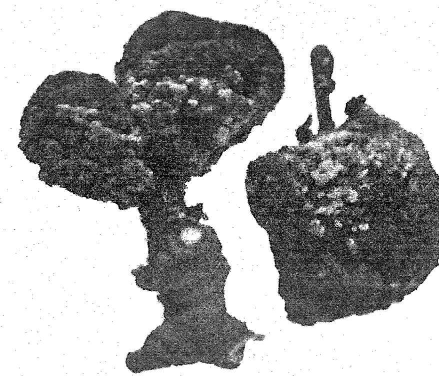
End of a gooseberry shoot (*Berry's Early*) severely attacked by the American Gooseberry-Mildew. The uppermost leaves have been so severely attacked that they have not grown out. These young distorted leaves are completely covered over with the brown "winter-stage" of the mildew, and on falling to the ground infest the soil.

PLATE IV.

[W. H. Hammond, photo.

Apples attacked by the "Brown Rot" fungus.

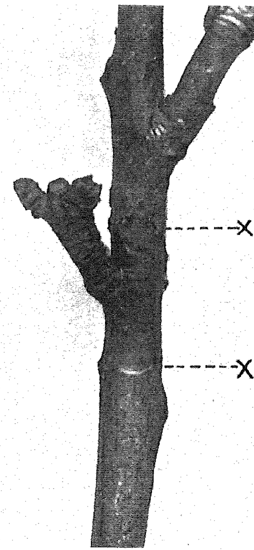
PLATE V.



[W. H. Hammond, photo.

Dried-up "mummied" apples, bearing the "Brown Rot" fungus. These apples (of the previous year's growth) were taken from an apple tree when in flower.

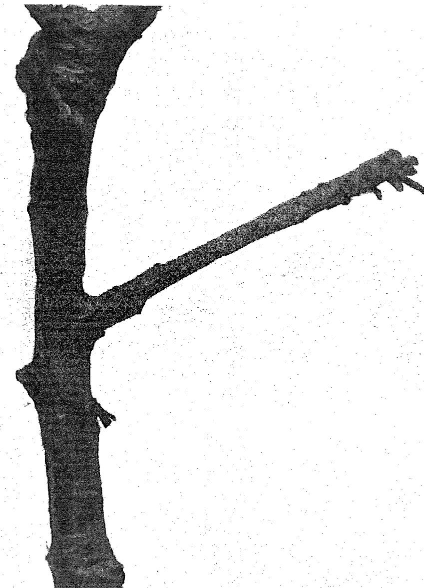
Plate VI.



[W. H. Hammond, photo.

A small "canker" formed by the "Brown Rot" fungus.

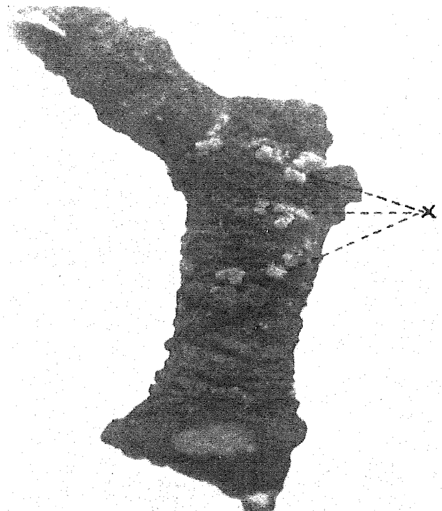
Plate VII.



[W. H. Hammond, photo.

A small "canker" formed by the "Brown Rot" fungus.

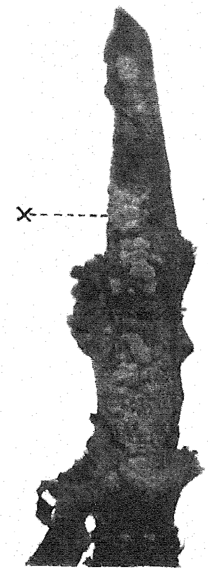
PLATE VIII.



[W. H. Hammond, photo.

Pustules of spores of the "Brown Rot" fungus.

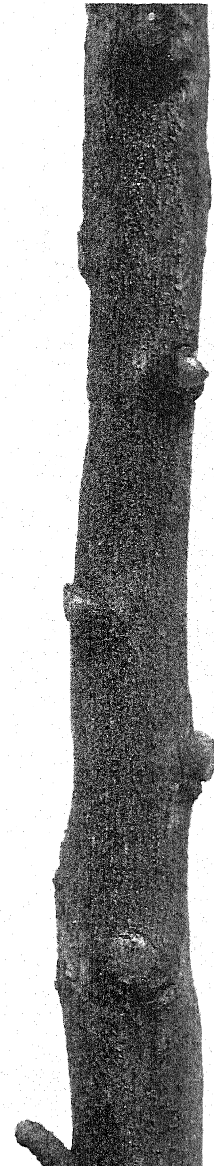
PLATE IX.



[W. H. Hammond, photo.

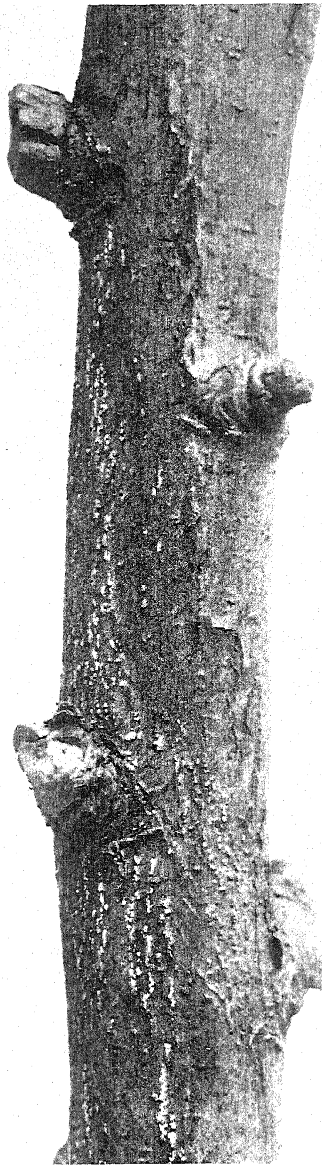
Pustules of spores of the "Brown Rot" fungus.

PLATE X.



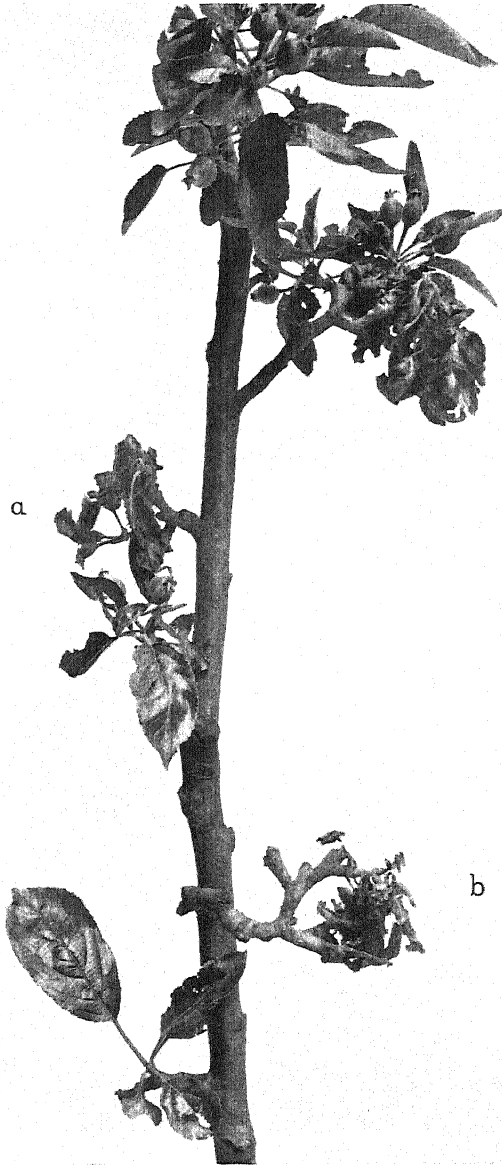
"Canker" produced by the "Brown Rot" fungus on a branch of "James Grieve."

PLATE XI.



Portion of the "canker" shown in *Plate* 10. Pustules of spores of the "Brown Rot" fungus can be seen in cracks in the bark.

Plate XII.



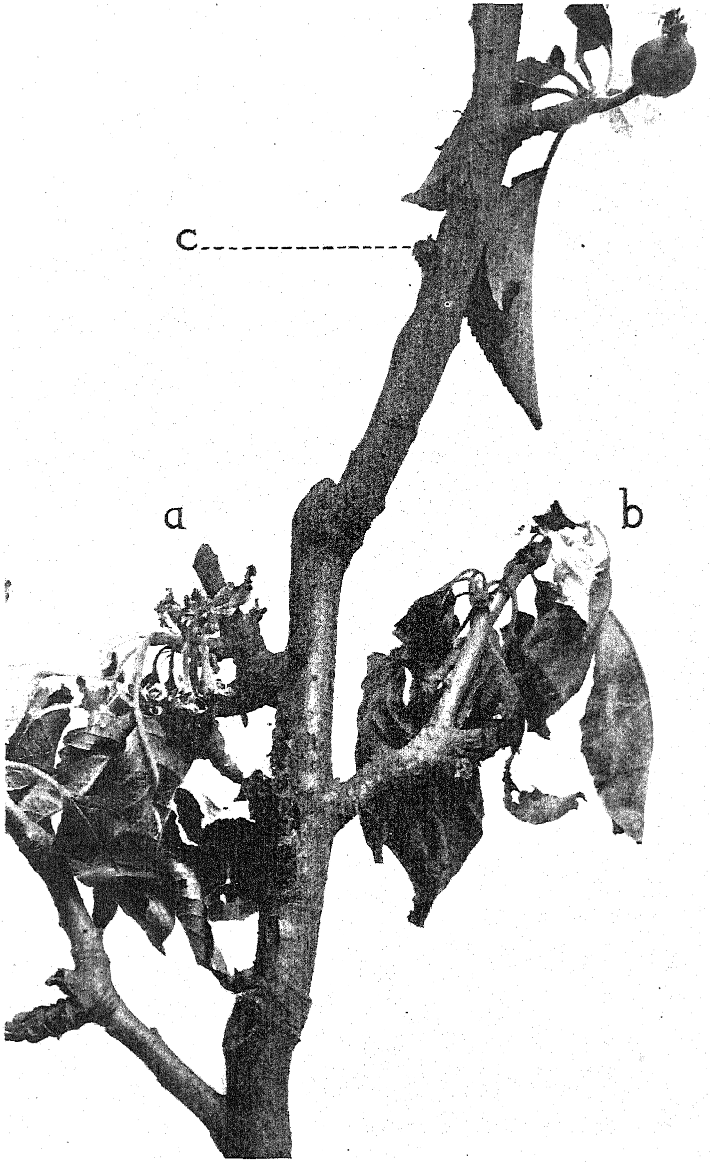
Portion of branch of Cox's Orange Pippin ; the flower-spurs at *a* and *b* have been attacked and killed by the " Brown Rot " fungus.

Plate XIII.

Portion of branch of Cox's Orange Pippin; the "Brown Rot" Fungus, entering through the flower-spurs (as at *a*) has caused a "canker."

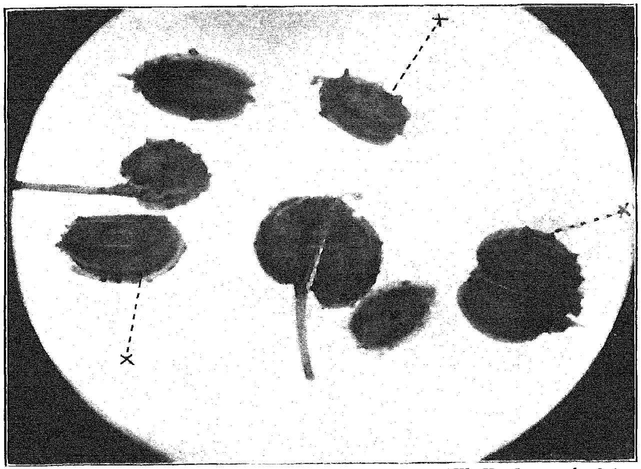
PLATE XIV.

The same branch as in *Plate* 13, seen from the opposite side. The branch is almost girdled by the "canker"; pustules of spores are appearing in the cracks in the bark



" Brown Rot " canker in a branch of Cox's Orange Pippin ; the remains of the dead spur where the fungus entered can be seen at *c*. Fresh shoots have been attacked at *a* and *b*.

PLATE XVI.



[W. H. Hammond, *photo.*

Photomicrograph of diseased Celery Seeds, showing (as at *x*) the fruit-conceptacles (*pycnidia*) of the fungus *Septoria* (magnified).

PLATE XVII.

[H. Wormald, *photo.*

Portion of a root showing the white strands of *mycelium* of the "White Root Rot" fungus.

PLATE XVIII.

[*H. Wormald, photo.*

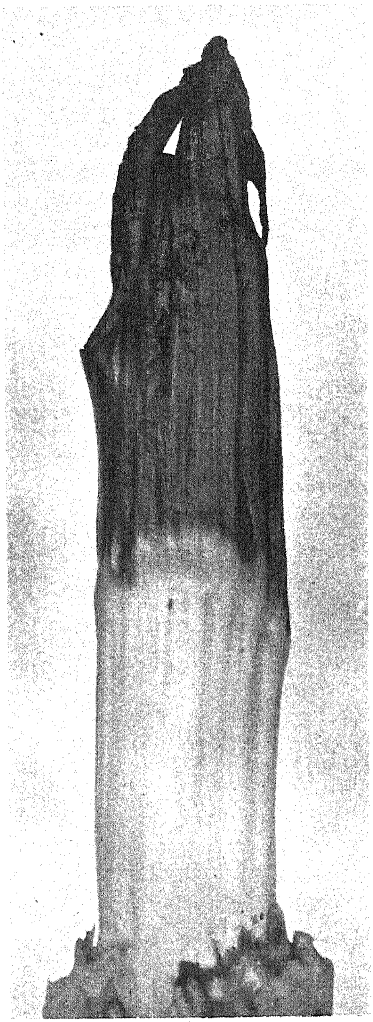
Portion of Broccoli-leaf, showing "Leaf-spot."

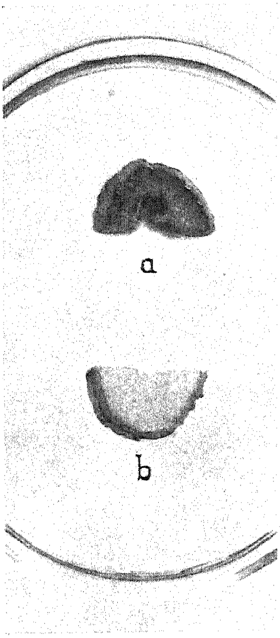
PLATE XIX.

[H. Wormald, photo.

Naturally infected Celery showing inner leaves with "soft-rot"—outer leaves removed.

PLATE XX.





No. 2.

[H. Wormald, photo.

No. 1.

No. 1. Naturally infected Celery "heart" with "soft-rot."

No. 2. A slice of Celery "heart" cut into halves, one (*a*) inoculated from a pure culture, the other (*b*) control, showing result four days after (*a*) was inoculated.

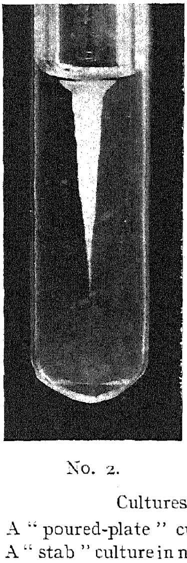
PLATE XXI.

[*H. Wormald, photo.*

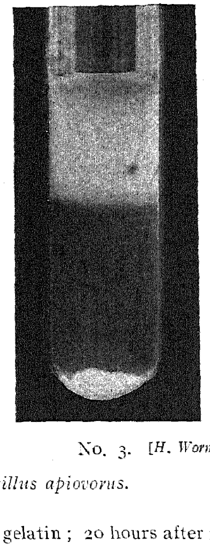
A Celery plant two days after the leaf on the left was inoculated; the leaf on the right was the control, *i.e.*, similarly wounded but not inoculated.

PLATE XXII.

No. 1.



No. 2.

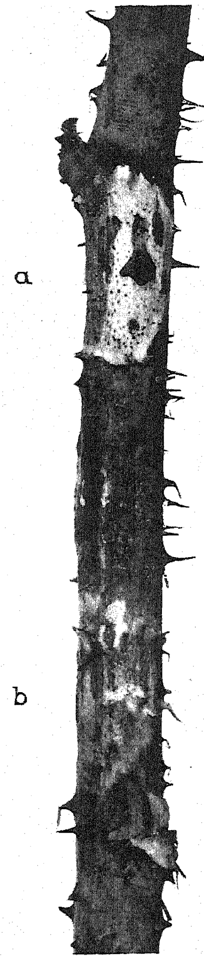


No. 3. [*H. Wormald, photo.*

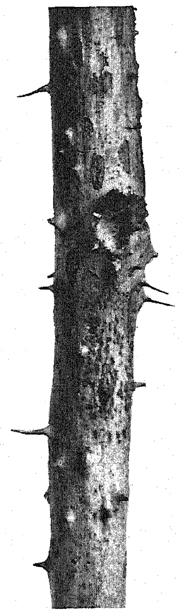
Cultures of *Bacillus apiovorus.*

No. 1. A " poured-plate " culture.
No. 2. A " stab " culture in nutrient gelatin ; 20 hours after inoculation.
No. 3. Complete liquefaction of the gelatin after 12 days.

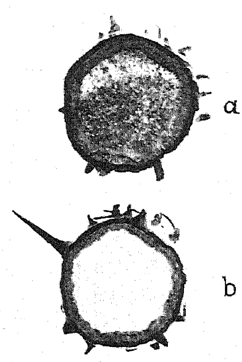
PLATE XXIII.



No. 1.



No. 2.



No. 3. [*H. Wormald, photo.*

No. 1. Loganberry cane showing at *a* a " canker " with *Coniothyrium* Fuckelii ; at *b* is an incipient canker.

No. 2. Loganberry cane with fructifications of *Hendensonia rubi* × 1½.

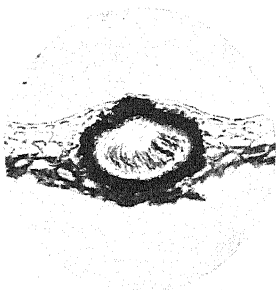
No. 3. Sections of the cane shown in No. 1. *a* taken through the canker and *b* at one inch above it.

PLATE XXIV.

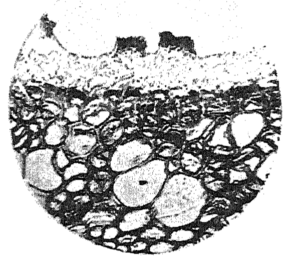
[H. Wormald, photo.

Loganberry cane with fructifications of *Didymella applanata*.

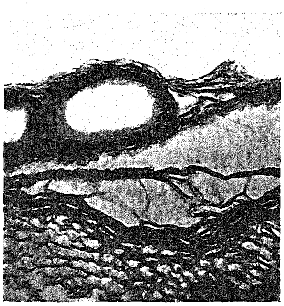
PLATE XXV.



No. 1.

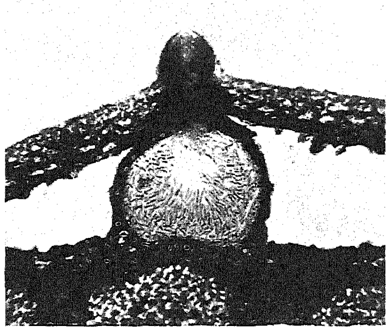


No. 2.



No. 3.

No. 4.



No. 5. [*H. Wormald, photo.*

Fungi seen in transverse sections of Loganberry canes:

(1) *Didymella applanata*, × 100. (2) Sclerotia-like bodies of a fungus not identified, × 100. (3) and (4) *Coniothyrium Fuckelii*, × 100. (5) *Gnomonia rubi*, × 80.

from year to year, and also with the spread of Potato blight, to know whether the fungus can freely pass from this plant to the potato and *vice versâ*. Experiments on this point do not seem to have been recorded. Repeated attempts were made to infect *S. dulcamara* (and also *S. nigrum*) with the sporangia from the potato, but always without success. Other species of *Solanum*, and also *Physalis* and some other plants were inoculated with negative results (see table below). In carrying out these experiments the young plants in small pots of soil were placed under a cloche and arranged so that they were not in contact. Under each cloche so used a healthy potato shoot was placed, inoculated with the same suspension as the other plants, and kept as a control under the cloche for the same length of time.

The potato leaves in each case were infected with the fungus, but the other plants remained free from it.

For the purpose of obtaining material for inoculation, *S. dulcamara* was planted in the College Botanic Garden. On September 13th, on a plant situated in a shady corner of the Garden I observed a few leaves which were darkened in patches and thus bore a striking resemblance to a "blight" attack. No sporangia were observed on these leaves, but on being placed in a moist chamber in the laboratory, they developed them. During the week following, sporangia were produced on the leaves on the one plant in the shady corner, but not elsewhere. With the limited amount of sporangia available, slices of potato, and also potato leaves, were inoculated and kept under suitable conditions with controls. No infection resulted on the potato leaves but the slices, with a few exceptions, produced sporangia of *Phytophthora*, the controls remaining free.

Inoculations with Sporangia of *Phytophthora infestans*.

No. of Expt	Origin of Sporangia.	Plant inoculated.	Result.
1	Potato.	*Solanum aviculare*	+
		Potato	+
2	Potato ..	*Physalis edibulis*	—
		Physalis lanceolata	—
		Solanum aviculare	+
		Potato	+

No. of Expt.	Origin of Sporangia.	Plant inoculated.	Result.
3	Potato ..	*Solanum robustum*	—
		S. capsipistrum	—
		Egg-plant	—
		Potato	+
4	Potato ..	*Nicandra physaloides*	—
		Hyocyamus niger	—
		Physalis Bunyardi	—
		Potato	+
5	Potato ..	*Datura stramonium*	—
		Solanum balbisii	—
		Potato	+
6	Potato ..	*S. dulcamara*	—
		Physalis alkekengi	—
		P. Franchetti	—
		Potato	+
7	Potato ..	*S. nigrum*	—
		Tomato (leaf and fruit)	—
		Potato	+
8	Potato ..	*S. nigrum*	—
		S. dulcamara	—
		Potato	+
9	*S. dulcamara*	*S. dulcamara*	+
10	*S. dulcamara*	Potato (leaf)	—
		Potato (cut tuber)	+

Conclusions.

The spores of *P. infestans* on Potato in this country are able to infect *Solanum aviculare,* as has been found to be the case in Australia. Negative results were obtained with the fungus on Potato when sown on *Tomato, S. dulcamara* and *S. nigrum.*

NOTES ON HOPS,

1912–13 and 1913–14.

BY

E. S. SALMON, F.L.S.

NOTES ON HOPS, 1912-13.

By E. S. SALMON, F.L.S.

1.—On the Raising of New Varieties from Seed.

As in previous years the work of raising new varieties of hops by "crossing" different English and foreign varieties has been continued. The female parents used for the new "crosses" were as follows: the German varieties at Wye which have shown in many seasons a high percentage of soft resins, viz., Late Bavarian; Elsass; and a late variety (name unknown), *Ref. No.* 260-1; also Canterbury Whitebine; Early Bird; three Seedling Hops (raised previously) of the following parentage: Fuggles × green-bined English male (*Ref. Nos.* 141, 255, 284), and a Hop of unknown parentage, believed to be a Seedling (*Ref. No. D* 9). These female hops were crossed with various selected English, German and American male hops. Seed was also collected from a Seedling (*Ref. No. K* 52) of the Oregon "Cluster" hop, raised at Wye in 1910.

We have now a number of promising "seedling" hops available for trial by hop-growers in Kent, Surrey or Sussex. A considerable number of these seedlings have obtained a favourable report in the Borough as to their flavour, and have shown on chemical analysis a high percentage of soft resins. Their cropping power and general characteristics now remain to be tested in commercial hop-gardens on the various soils in the counties. This work is already well started.

During the season of 1912 nine parties of hop-growers visited the College hop "nursery" and selected new "seedling" hops for testing in the soils of their own hop-gardens. "Cuts" from these new seedlings were sent out to the grower in the autumn. In all, 374 "cuts" of thirteen different varieties were supplied to eleven growers at Chilham, Horton

Kirby, Paddock Wood, Dover, Woodnesborough, Brenchley, Goudhurst, Benenden and Cranbrook.

The College hop "nursery" is open to inspection at any time to hop-growers in Kent, Surrey or Sussex.

During 1912, as in previous seasons, hops from promising seedlings, and also from different English and foreign varieties grown at Wye, were picked and dried, and box samples submitted to factors and merchants in the Borough for opinions as to flavour, "condition," etc. The reports obtained, together with notes on the character of growth shown by each hop-plant, are given below.

CLASS I.—OF UNKNOWN PARENTAGE; BELIEVED TO BE "SEEDLINGS."

Ref. No. B 18.—Vigorous and very fruitful, striped bine; laterals of medium length; hops thickly set; hop oval, rather small. A late hop.

"Quite good, mild flavour" (Factor A); "sample too green to judge" (Factor B).

Ref. No. E 1.—Very vigorous and fruitful; striped bine; laterals very short; hops thickly set; hop medium size, oval, occasionally "leafy."

"Nothing in it" (Factor B).

CLASS II.—SEEDLING HOPS OF KNOWN PARENTAGE.

Ref. Nos. J 1, J 9, J 18, N 22, N 29, Q 30, Q 31, Q 50, R 9, (German variety *Stirn* × early-flowering English male (*Ref. No.* Z 12.)

No. J 1.—Very vigorous and fruitful; bine mottled red; hop pale green; medium size to long; "petals" rather distant on strig,—hop not of *Stirn* type.

"Very mild flavour" (Factor A).

No. J 9.—Very vigorous and very fruitful; bine red; hop more or less cylindrical, with reddish tinge,—not of *Stirn* type; a medium-late hop.

"Mild flavour" (Factor A).

No. J 18.—Vigorous and fruitful; bine mottled; hop large, often leafy, of *Stirn* type.

"Very strong, garlic flavour; more condition" (Factor A).

No. N 22.—Very vigorous and very fruitful; bine mottled to reddish; hop shorter, denser and more compact than *Stirn*.

"Very mild flavour" (Factor A).

No. N 29.—Fairly vigorous and fruitful; bine green; *Stirn* type of hop, but slightly longer, sometimes very leafy.

"Good, mild flavour" (Factor A).

No. Q 30.—Nor very fruitful; bine mottled; hop green, of *Stirn* type.

"Not so good as Q 31; not much in it" (Factor A); "Very mild, English flavour" (Factor B).

No. Q 31.—Vigorous and fruitful to low down; bine green; hop green, of *Stirn* type. Mid-season.

"Very good flavour" (Factor A); "quite different, *English* flavour, and worth going on with; the best of these samples" (Factor B); "strong Fuggles flavour; should be worth cultivating" (Factor D).

No. Q 50.—Vigorous and fairly fruitful; bine grèen; hop occasionally leafy, of *Stirn* type.

"Much stronger, good flavour" (Factor A); "very strong, garlic flavour" (Factor B); "powerful hop, pungent flavour, not garlic" (Factor D).

No. R 9.—Fairly vigorous and fruitful, bine mottled; hop green, large, oblong, cylindrical, pointed. Early mid-season.

"Flavour very mild" (Factor A); *filthy* flavour" (Factor B); "peculiar, sweet flavour, rubs down well; should be worth cultivating" (Factor D).

Ref. Nos. J 29; Q 25 (German variety *Stirn* × English male hop).

No. J 29.—Vigorous and fairly fruitful, hop green, cylindrical and long, sometimes leafy. An early hop.

"Very mild, not unpleasant flavour" (Factor A); "sweet flavour, no trace of garlic" (Factor B).

No. Q 25.—Vigorous and fruitful; bine mottled; hop very occasionally leafy; of *Stirn* type.

"Good, strong flavour" (Factor A).

Ref. Nos. T 175, T 179.—(Seedlings of German variety, *Stirn*).

No. T 175.—Vigorous and fruitful; hop of medium size, with reddish tinge. Mid-season to late.

"Very good mild flavour, with more rub" (Factor A); "nothing in it" (Factor B).

No. T 179.—Fairly vigorous and fruitful; hop compact, green or with reddish tinge. Mid-season to late.

"Flavour good, fairly strong" (Factor A); "nothing in it" (Factor B).

Ref. Nos. 411, 432, S 4, S 14, S 16 (*Prolifics* × English male hop).

No. 411.—Rather weak growth, habit of Prolifics. A very early hop.

"Not much in it" (Factor A); "Do not care for it" (Factor B).

No. 432.—Fairly vigorous and fruitful; hop small, green. An early hop.

"Nothing in it" (Factors A and B).

No. S 4.—Vigorous and fruitful; hop green, rather small. An early hop.

"Not much in it" (Factor A); "not the flavour of Prolifics,—an improvement on it" (Factor B); "no good, nothing in it" (Factor D).

No. S 14.—Vigorous and fruitful; hop green, medium-sized, a bold hop. Mid-season.

"Not much in it" (Factor A); "nothing in it" (Factor B).

No. S 16.—Vigorous and fruitful; hop green, medium-sized, rounded, of *Golding* type, mid-season to late.

"Not much in it" (Factor A); "nothing in it" (Factor B).

Ref. No. P 13.—Seedling of German variety *Saaz* (*Halledau*). Very vigorous, fairly fruitful; hop green, large, squarish, dense with crowded petals.

"Very nice hop, good bold size; flavour pleasant, English, good condition" (Factor A); "like it very much" (Factor B); "a good hop, strong flavour, should be valuable, I place it second of all your samples this year" (Factor D).

Ref. Nos. 339, 350, L 47, L 49, (Seedlings of *Ref. No.* D 5 (a hop of unknown parentage, believed to be a seedling)).

No. 339.—Vigorous and fruitful; hop green, small to medium, mid-season to late.

"Nothing distinctive" (Factor B).

No. 350.—Vigorous and fruitful; hop green, large. A heavy cropper.

"Fairly strong flavour, poor condition" (Factor A); "Not enough flavour" (Factor B).

No. L 47.—Fairly vigorous, not very fruitful; hop green, small, clustered.

"Mild flavour, with condition; a fair hop" (Factor A); "a nice hop, but not outstanding" (Factor B).

No. L 49.—Vigorous and fruitful; hop green, with reddish heel, compact, squarish, good condition. Mid-season to late.

"Stronger flavour, good condition, a better hop than *L* 47" (Factor A); "inferior to *L* 47" (Factor B).

Ref. No. L 46.—(Seedling of *Ref. No.* H 13 (Saaz × English male hop).)—Very vigorous, fruitful; very stout red bine; hop green, long, medium size.

"Nothing in it" (Factors A and B).

Ref. Nos. O 35, T 125 (*Ref. No.* H 13 (Saaz × English male hop) × English male hop).

No. O 35.—Vigorous and fruitful; hop green, large, long, sometimes leafy. Mid-season.

"Aromatic, not Golding flavour" (Factor A); "not much in it" (Factor B).

No. T 125.—Vigorous and fruitful, hops clustered on short laterals; hops green, pointed, medium size. An early hop.

"Hardly ripe, not Golding flavour" (Factor A); "nothing in it" (Factor B).

Ref. No. M 23.—(*Ref. No.* D 9 (a hop of unknown parentage, believed to be a seedling) × English male hop).)—Vigorous and very fruitful; hop green, thick, medium size. Early to mid-season.

"Pleasant flavour, fair condition" (Factor A); "nothing in it" (Factor B).

Ref. Nos. L 16, L 17, L 20, L 21, L 22, L 24, L 29, L 36, L 37, T 14, T 17.—(*Tolhurst* × English male hop (*Ref. No.* C 7).)

No. L 16.—Fairly vigorous; fairly fruitful; hop green, medium size. Early to mid-season.

"Not Golding flavour" (Factor A).

No. L 17.—Vigorous and fruitful, hop green, with reddish tips to petals, medium size. Early to mid-season.

"Pungent, oniony flavour" (Factor A); "flavour of Tolhurst" (Factor B).

No. L 20.—Vigorous and fruitful; hops clustered; hop medium sized, with a tinge of red at heel. Early to mid-season.

"Flavour mild, not Golding and little of it" (Factor A); "has Tolhurst flavour and appears identical with this variety" (Factor B).

No. L 21.—Very vigorous and fruitful; hops densely clustered, hops green, medium size to small. Early to mid-season.

"Comes next to *L* 22 for flavour, but it is not Golding" (Factor A); "has Tolhurst flavour" (Factor B).

No. L 22.—Vigorous and fruitful, hops clustered; hop green, medium to small, compact. Mid-season.

"Some condition, flavour mild, not Golding,—the best of Nos. L 20, L 21, L 22" (Factor A); "Has Tolhurst flavour" (Factor B).

No. L 24.—Vigorous and fruitful; hop green, medium to large. Early to mid-season.

"Not Golding flavour" (Factor A).

No. L 29.—Vigorous and fruitful; laterals very long, fruitful to low down, hop pale green, medium to large. Mid-season.

"Not Golding flavour" (Factor A).

No. L 36.—Very vigorous and fruitful, hops clustered; hop green, bold, medium size, slightly furrowed, compact. Mid-season.

"Not Golding flavour" (Factor A); "shows some promise" (Factor B).

No. L 37.—Very vigorous and fruitful; hops clustered; hop green, compact. Mid-season.

"Better flavour than Tolhurst, but not Golding" (Factor A).

No. T 14.—Vigorous and fruitful; bold green hop; large, compact, squarish. Mid-season.

"Pungent, oniony flavour, full of condition" (Factor A); "I like this hop, a marked improvement on the Tolhurst" (Factor B); "a fine bold hop, but flavour rank,—not an improvement on the Tolhurst" (Factor D).

No. T 17.—Vigorous and fruitful; hops clustered; hop green, large. An early hop.

"*Strong* flavour, not Golding,—might be of use" (Factor A); "there is some promise shown here" (Factor B).

Ref. Nos. M 28, M 31, M 38.—(Seedlings of German variety, Upper Bavaria.)

No. M 28.—Vigorous and fruitful; hop green, medium size, compact. Mid-season.

"Flavour mild, good condition" (Factor A); "nothing in it" (Factor B).

No. M 31.—Vigorous and very fruitful, hop green, medium size, compact. Mid-season.

"Similar to M 28" (Factor A); "nothing in it" (Factor B).

No. M 38.—Vigorous and fruitful; hop green, medium to large, rather coarse, sometimes flattened. Mid-season.

"Very good flavour, mildish, with condition—better than M 28 and M 31" (Factor A); "not much in it" (Factor B).

Ref. No. 271.—*Ref. No.* C 15 (a hop of unknown parentage, believed to be a seedling × English male hop (*Ref. No.* F 5).)—Fairly vigorous and fruitful. Early to mid-season.

"Aromatic flavour, not Golding" (Factor A); "of promise, may make a good hop,—not Golding flavour" (Factor B); "useful quality, pleasant flavour" (Factor D).

Ref. No. T 48.—(Seedling of *Ref. No.* C 19 (a hop of unknown parentage, believed to be a seedling).—Vigorous and fruitful; hop green, medium size. Early to mid-season.

"Flavour inclined to be rank, though not offensive" (Factor A); "Nothing in it" (Factor B).

Ref. Nos. 34, 54, 125.—(Early White × male hop growing among Early Bird).

No. 34.—Vigorous and fruitful; hop green, large, bold. An early hop.

No. 54.—Very vigorous and very fruitful; laterals short; hop large, green, rounded.

No. 125.—Vigorous and fruitful; laterals short, closely set; hop green, thick.

"I place *No.* 54 first, with a very mild, true Golding flavour, and *No.* 125 second, with very similar, but not so mild a flavour, which has a little twang in it" (Factor A); "place *No.* 54 first, and *Nos.* 34 and 125 equal for second place" (Factor B); "*No.* 54 is the best of all the samples this year, has Golding flavour, and rubs down well" (Factor D).

Ref. No. 276.—(Seedling of *Oregon* hop (*Ref. No.* F 19 or F 20).—Fairly vigorous and fruitful; hop green, *small.* Decidedly earlier hop than the *Oregon.*

"Typical Oregon flavour, distinct and very strong" (Factor B); "distinct Oregon flavour" (Factor D)

Class III.—Foreign Varieties Grown at Wye.

German variety Stirn.—Fairly vigorous; not fruitful; hop very large, coarse, often leafy. A very early hop.

"Very mild flavour" (Factor A); "rather a pleasant flavour" (Factor B); "poor and rank flavour" (Factor D).

German variety Holledau (plant originally obtained from Marzill, 1900).—Fairly vigorous and fruitful; hop medium-sized. Mid-season.

"Pleasant flavour, with some condition, though not much" (Factor A); "what little there is, is a good, distinctly German flavour" (Factor B); "pleasant flavour, but weak compared with the original" (Factor D).

German variety Late Bavarian.—Vigorous, fairly fruitful; hop long, not coarse. Very late.

"Good condition, flavour mild, shows perhaps some promise" (Factor A); "not unpleasant flavour, but nothing in it" (Factor B).

German variety (name unknown, *Ref. No.* 263-4). Very vigorous and fruitful; hop long and very large, not coarse. A very late hop.

"A good hop, with pleasant mild flavour" (Factor B); "poor and weak" (Factor D).

Danish variety "Asperup" (plant originally obtained from Island of Fyen, Denmark, April, 1911).—Weak growth; hop green, medium size. Early to mid-season.

"Very weak flavour, nothing distinctive" (Factor A); "not much in it, does not stand out" (Factor B).

Danish variety "Groen Humle" (from Denmark, April, 1911).—Not vigorous; hop medium size, green, mid-season.

"Nothing in it" (Factor A); "Not much in it" (Factor B).

In continuation of the work started in 1909, viz., the collection of information as to the production of resins in different varieties of hops, a number of dried samples of "seedlings" and other hops growing in the College Experimental Hop-garden, and also samples of English and foreign hops kindly supplied by hop-merchants, were analysed by Mr. R. H. Carter in the College Chemical Laboratory, and their soft resins content determined by the method of analysis described in this *Journal*, Vol. XIX, p. 375. Owing to the unfavourable season, and prevalence of "blight," fewer samples were analysed than in previous years, and for the same reasons difficulty was experienced as regards samples of the

hops growing at the College in obtaining satisfactory duplicates for the determination of the percentage of resins. The results of the analyses are given below:

TABLES SHOWING PERCENTAGE OF SOFT RESINS.

CLASS I.—HOPS OF UNKNOWN PARENTAGE; BELIEVED TO BE SEEDLINGS.

Reference No.	A. Per cent.	B. Per cent.	Average. Per cent.
E1	8.36	7.97	8.17

The characteristics of this hop are given under the reference number at p. 500.

CLASS II.—SEEDLING HOPS OF KNOWN PARENTAGE.

Reference No.	A. Per cent.	B. Per cent.	Average. Per cent.
Q31	6.60	6.78	6.69
Q50	7.52	6.92	7.22
R9	11.46	11.63	11.55
S4	9.64	9.10	9.37
P13	9.03	8.27	8.65
T14	7.39	6.32	6.86
271	7.17	7.14	7.16
54	7.47	7.88	7.68
125	10.18	10.41	10.30
276	12.86	12.22	12.54

The parentage and characteristics of these hops are given, under their respective numbers, at p. 501.

Class III.—German Varieties of Hops grown at Wye College since 1902.

Name of Variety.	A. Per cent.	B. Per cent.	Average. Per cent.
Holledau (from Marzill) ..	5.96	5.41	5.69
Late Bavarian ..	10.0	9.20	9.60
Late variety (name unknown) (Ref. No. 263-4) ..	6.97	7.51	7.24*

The characteristics of these hops are given, under their respective names, at p. 506.

Class IV.—English Varieties.

Name of Variety.	A. Per cent.	B. Per cent.	Average Per cent.
Canterbury Whitebine (grown at Wye College) ..	10.03	9.24	9.64
†Choicest East Kent Goldings ..	12.45	12.98	12.72
†Choicest Kent Fuggles ..	8.95	10.05	9.50
†Choicest Worcesters ..	12.60	13.12	12.86

Class V.—German Variety grown in Bavaria.

Name of Variety.	A. Per cent.	B. Per cent.	Average Per cent.
‡Choice Holledaus ..	11.40	10.53	10.97

* Some "lice" present in the hops.

† These samples were supplied by factors and merchants as illustrating "the best growths of the year."

‡ This sample was supplied by merchants as illustrating "the best growth of the year."

Class VI.—American Variety grown in America.

Name of Variety.	A. Per cent.	B. Per cent.	Average Per cent.
Choicest Oregons ..	12.03	12.07	12.05

Reviewing the above Tables, we see that the samples of "choicest Worcesters" and "choicest East Kent Goldings" come highest with 12.86 per cent. and 12.72 per cent. respectively. The next place is taken by a Seedling (*Ref. No.* 276) raised at Wye, with 12.54 per cent. This seedling was raised in 1909 from a seed, the result of chance pollination, of the Oregon "Cluster" hop—plants of which were obtained in 1908 through the courtesy of Messrs. Wigan, Richardson & Co. This seedling (*Ref. No.* 276) shows little or no commercial promise, since the hops produced so far are individually too small, and their flavour distinctly and strongly that of Oregon hops as grown in Oregon. The high percentage of resins shown by this seedling is a fact of considerable importance, and encourages the hope that if a number of plants are raised, some hybrids of this Oregon hop "crossed" with English male hops may be found to possess the desired English flavour with the high resins-content characteristic of many samples of the Oregon hop when grown in Oregon. A considerable number of seedlings of the above parentage have now been raised at Wye, and will be ready for testing next year.

The next highest in resins is the sample of "choicest Oregons" grown in Oregon, with 12.05 per cent. This is followed by the Seedling hop, *Ref. No.* R 9, with 11.55 per cent. This seedling, raised in 1909, is a hybrid between the German variety *Stirn* and an early-flowering English male hop (*Ref. No.* Z 12) (see above, p. 501). The hops have a strong, *new* flavour, and, if the cropping powers of the plant prove sufficiently good, a brewing trial will be made.

The next highest is the sample of "choice Holledaus," grown in Bavaria, with 10.97 per cent. It is to be noted that the sample of Holledaus, obtained in 1910 from Bavaria

and since grown at Wye, averaged this season only 5.69 per cent.

The Seedling hop, *Ref. No.* 125, comes next with 10.30 per cent. This Seedling was obtained from a " cross " made in 1906, between the " Early White " variety and an English male hop. It has received good reports on the Borough as to its flavour, and may be called a Golding hop. It is already being tested in the county, and " cuts " for this purpose are now available to hop-growers in Kent, Surrey or Sussex.

Among points of interest in connection with the Factors' reports on the samples of the new seedling hops submitted to them, the following may be noted.

Some of the Seedlings raised from the Tolhurst (see p. 504), a variety chosen because of its great vigour and fruitfulness, show *an improvement in flavour* over that of the Tolhurst. If in any of the seedlings of this " cross " this improved flavour is found united with the original Tolhurst fruitfulness, a valuable hop will have been bred.

One of the Seedlings (*Ref. No.* J 29) of the " cross " *Stirn* × Z 12 (see p. 501) is a very early hop, with a not unpleasant flavour. If the cropping powers and resins-content prove satisfactory, this plant or another seedling of the same "cross," may prove valuable in the place of the " Prolifics," an old variety which is unsatisfactory in many ways. A photograph of a branch of J 29 is given in Plate 1.

The Seedling, *Ref. No.* P 13, raised from the German variety Saaz, bears hops of a very distinct and good type, the " petals " being very crowded and so resembling the structure of the best German hops. This plant, however,—which is still too young to be judged—has not so far shown very promising cropping powers.

2. The sending out of Male Hops to Growers in Kent, Surrey and Sussex.

During the winter of 1912-13, applications for our selected male hops were received from *sixty* hop growers in Kent, Surrey and Sussex. One hundred and twenty hills of male hops, selected for vigour and time of flowering, are now cultivated in the hop-garden, from which " cuts " are sent out so that

growers can raise from them their own stock of male hops suitable for planting with the different varieties.

Fifty-eight growers were supplied this season with 2,694 "cuts" of male hops selected to flower early or late, or mid-season; only two applicants having to be placed on the "waiting-list." These "cuts" were sent to growers in the following parishes: *Kent*: Staplehurst, Southfleet, Marden, Otford, Fordcombe, Chatham, Wateringbury, Horton Kirby, Hinxhill, Tenterden, Rolvenden, Woodchurch, Maidstone, Smarden, Ditton, Paddock Wood, Plaxtol, Cranbrook, Stone-in-Oxney, Goudhurst, West Malling, Ightham, Matfield, Eastry, Shadoxhurst, Kingsnorth, Tonbridge and Sevenoaks. *Surrey*: Farnham. *Sussex*: Robertsbridge, Battle, Brede, Northiam, Uckfield, Eridge, Maresfield, Beckley, Wadhurst, Ticehurst. *Hants*: Petersfield, Bentley, Alton.

Hop-growers who intend to apply for male hops should note the period during which the hops among which the males are to be planted remain in "burr." If this information is sent to Wye College, "cuts" of suitable varieties of male hops will be supplied.

NOTES ON HOPS, 1913-14.

By E. S. SALMON, F.L.S.

1.—On the Raising of New Varieties of Hops from Seed.

In 1913 seed was obtained from the following sources :—

(1) The wild hop (*Humulus Lupulus* L.), from Vittorio, Italy, collected by Prof. P. A. Saccardo.

(2) Golding hops, grown at Marzill, Bavaria (probably the result of fertilization by German male hops).

(3) Oregon "Cluster" (*Ref. No.* F 19), grown at Wye College.

(4) A Seedling (*Ref. No.* M 45) of the above.

(5) Fuggles, grown in Oregon.

During the season of 1913 visits were paid to the College hop-nursery by over twenty hop-growers, who selected for trial in their hop-gardens several of the most promising-looking Seedlings. In all, 2,830 "cuts" from twenty-three different varieties were distributed to twenty-nine hop-growers farming at Brenchley, Harbledown, Selling, Paddock Wood, Dover, Woodnesborough, Hawkhurst, Leigh, Canterbury, Chilham, Goudhurst, Cranbrook, Barming, Yalding, Marden, Horton Kirby, Wateringbury, in Kent; Bodiam, Midhurst, Battle, Ticehurst, Uckfield, in Sussex.

In addition to the above, 202 "rooted sets" of ten varieties have been planted in the Experimental Hop-garden at the College Research Station at East Malling.

The college hop-nursery is open to inspection at any time to hop-growers in Kent, Surrey or Sussex.

As in previous seasons, samples of hops were collected from the most promising seedling and other varieties and dried and pressed into box samples for report as to flavour, etc., by experts in the Borough. The reports obtained, together with notes on other characteristics, were as follows :—

Class I.—Of Unknown Parentage; believed to be Seedlings.

Ref. No. B 18.—Vigorous and very fruitful; striped bine; laterals of medium length, with hops thickly set; hop oval, medium to small. Late hop.

"Very nice flavour, should say was as good a hop as Fuggles" (Factor A); "poor in colour, good, mild flavour, fair rub" (Factor D).

Class II.—Seedling Hops of Known Parentage.

Ref. Nos. J 24, N 26, Q 44, Q 51, R 5, R 9 (German variety *Stirn* × early-flowering English male hop (*Ref. No.* Z 12)).

Ref. No. J 24.—Vigorous and fruitful; bine green; hop green, not of *Stirn* type. Early to mid-season.

"Quite good flavour, nothing German in it" (Factor A); "pleasant flavour, probably worth going on with; I place it first of the samples of this cross" (Factor B); "Coarse quality, poor flavour, poor rub" (Factor D).

Ref. No. N 26.—Not fruitful; bine green; hop long. Early hop.

"Mild flavour" (Factor B).

Ref. No. Q 44.—Fairly vigorous and fruitful; bine very stout; hop green, off *Stirn* type. Early to mid-season.

"Not distinctly good" (Factor A); "like it, pleasant flavour, more like Continental; I place it second of these samples" (Factor B); "Quality good; flavour and rub good" (Factor D).

Ref. No. Q 51.—Not very vigorous or fruitful; bine green; hop green, resembling *Stirn* type. Early hop.

"Distinctly unpleasant flavour" (Factor B).

Ref. No. R 5.—Vigorous and fairly fruitful; bine stout, green; hop of *Stirn* type. Early hop.

"Very mild flavour" (Factor B).

Ref. No. R 9.—Fairly vigorous and fruitful; bine mottled; hop large, green, oblong-cylindrical, pointed. Early to mid-season.

"Not good, pure flavour" (Factor A); "very mild" (Factor B).

Ref. Nos. J 29, N 33.—(German variety *Stirn* × English male hop).

Ref. No. J 29.—Vigorous and fairly fruitful; hop green, long, cylindric, sometimes leafy. Early hop.

"Quite good flavour, nothing German in it; shows promise; worth more money than any Prolifics" (Factor A); "rather like it; worth going on with; better than N 33" (Factor B); "coarse quality, fair flavour and fair rub" (Factor D).

Ref. No. N 33.—Vigorous and fairly fruitful; hop of *Stirn* type, shorter, compact. Early.

"Very little flavour" (Factor B).

Ref. Nos. S 4, S 9.—(Prolifics × English male hop).

Ref. No. S 4.—Vigorous and fruitful; hop green, rather small. Early.

"Common, not good flavour" (Factor A); "not ripe; not promising" (Factor B); "fair quality, fair flavour and fair rub" (Factor D).

Ref. No. S 9.—Vigorous; very fruitful; hop of medium size, rather long and green. Early to mid-season.

"Not ripe, don't care for it" (Factor B).

Ref. No. L 51.—(Seedling of *Ref. No.* D 5 (a hop of unknown parentage; believed to be a seedling)).—Vigorous and fruitful; hop medium-size, green with reddish markings. Late to mid-season.

"Common flavour" (Factor A); "does not stand out" (Factor B).

Ref. Nos. 339, 350.—(*Ref. No.* D 5 (hop of unknown parentage, believed to be a Seedling × English male hop)).

Ref. No. 339.—Vigorous and fairly fruitful; hop green, small to medium. Late to mid-season.

"Nothing objectionable in the flavour" (Factor A); "I like this hop; nice, mild, pleasant, not coarse flavour" (Factor B); "coarse quality, fair flavour, poor rub" (Factor D).

Ref. No. 350. Vigorous and fruitful; heavy cropper; large hop. Early.

"Rank flavour, do not like it; definitely not a Golding flavour" (Factor A); "I like this hop, distinctly a Golding flavour, good rub" (Factor B); "good quality, peculiar flavour, good rub; is the best early hop of yours we have seen" (Factor D).

Ref. Nos. L 43, S 72.—Seedlings of *Ref. No.* H 13 (Saaz × English male hop.)

Ref. No. L 43.—Fairly vigorous and very fruitful; hop green. Late to mid-season.

"Coarse flavour" (Factor A); "good, mild flavour, a very good hop, better than S 72" (Factor B); "pleasant quality, like a Golding, good flavour, and good rub" (Factor D).

Ref. No. S 72.—Vigorous and fairly fruitful; very large hop.

"Common flavour" (Factor A); "coarser flavour" (Factor B).

Ref. Nos. P 5, Y 79.—(*Ref. No.* H 13 (Saaz × English male hop) × *Ref. No.* B 11 (English male hop).)

Ref. No. P 5.—Very vigorous; fairly fruitful; hop coarse, very large. Early to mid-season.

"A stinking flavour" (Factor A); "don't like the flavour" (Factor B); "large, coarse hop; rank flavour; good rub" (Factor D).

Ref. No. Y 79.—Fairly vigorous and fruitful; hop medium to large, green.

"Coarse flavour" (Factor A); "peculiar sweet flavour" (Factor B); "fair quality; mild flavour; fair rub" (Factor D).

Ref. No. T 146.—(*Ref. No.* H 13 (Saaz × English male) × seedling English male hop, *Ref. No.* H 29 (Fuggles × English male hop).)—Vigorous and fairly fruitful; hop medium to large, rather coarse, green. An early hop.

"Do not like this flavour" (Factor A); "absolutely *new* flavour, must be judged on its merits by brewing trials" (Factor B); "good quality; flavour suggesting a mild Oregon; good rub" (Factor D).

Ref. No. S 74 ("cuts" from *Ref. No.* L 21) Tolhurst × English male hop (*Ref. No.* C 7).—Very vigorous and fruitful; hops densely clustered; hop green, medium size to small. Early to mid-season.

"Rank flavour though not so rank as that of Tolhurst, certainly an improvement on the ordinary Tolhurst" (Factor A); "good mild flavour, no Tolhurst flavour in it" (Factor B); "good and thick in quality, good strong flavour, good rub" (Factor D).

Ref. Nos. M 24, M 26.—(Seedlings of German variety, Upper Bavarian.)

Ref. No. M 24.—Fairly vigorous ; not fruitful ; hop of good appearance ; lupulin glands pale. Early to mid-season.

"Not the right flavour, but less objectionable than M 26" (Factor A) ; "good solid hop of nice shape, of Continental appearance, but not Continental flavour ; may have some promise ; better than M 26" (Factor B) ; "pleasant, silky quality ; suggesting some samples of Oregons ; flavour peculiar ; good soft rub" (Factor D).

Ref. No. M 26.—Vigorous and fruitful ; hop green, compact ; lupulin glands pale. Mid-season.

"Flavour wrong, of no good" (Factor A) ; "may have some promise ; nice-shaped hops ; (Factor B) ; "fair quality, mild flavour ; rub fair, soft" (Factor D).

Ref. Nos. S 24, No. 1.—(Seedlings of unknown parentage.)

Ref. No. S 24.—Vigorous and fruitful ; hop green, rather small. Late hop.

"New flavour, don't like it—has a distinct twang" (Factor A) ; "pretty hop, mild flavour ; worth going on with" (Factor B) ; "good quality, new, but pleasant flavour ; good rub" (Factor D).

Ref. No. 1.—Fairly vigorous ; fruitful ; hop rather small, green. Late hop.

"Not bad flavour ; good rub" (Factor A) ; "a fair hop" (Factor B) ; "good thick hop, mild flavour, good rub" (Factor D).

Ref. No. S 37.—(Canterbury Whitebine × English male).—Vigorous and very fruitful, forming a "crown" of hops ; hop small to medium, compact. Late to mid-season.

"New, but not objectionable flavour" (Factor A) ; "Golding flavour, not very strong ; I like this hop" (Factor B) ; "good thick hop ; mild, pleasant flavour ; very good rub ; a hop that should be worth encouraging" (Factor D).

Ref. Nos. 359, 372.—(Fuggles × green-bined English male hop.)

Ref. No. 359.—Vigorous and very fruitful ; bine mottled ; hop of medium size.

"Very poor hop ; not nearly so good as Fuggles, and

has not its flavour" (Factor A); "no promise, no Fuggles flavour" (Factor B).

Ref. No. 372.—Vigorous and very fruitful.

"A penetrating and good flavour,—nothing unpleasant in it" (Factor A); "flavour mild, not much in it; but try brewing with it" (Factor B); "fine quality, suggests Golding; very pleasant flavour, good rub" (Factor D).

Ref. No. P 43.—(Seedling of *Ref. No.* F 1, a hop of unknown parentage, believed to be a seedling.)—Vigorous and fruitful; a "whitebine," hop green, of good shape.

"Quite good flavour, related to the Golding flavour" (Factor A); "I like this hop and place it first among any of the above seedlings, though I am not quite pleased with the flavour; it is a nice-shaped hop and well worth going on with" (Factor B); "a good, thick hop; good, strong flavour; good rub" (Factor D).

Ref. Nos. K 16, T 111, W 10, Y 6.—Canterbury Whitebine × Seedling male hop (Fuggles × English male hop).

Ref. No. K 16.—Vigorous and fairly fruitful; hop small, green.

"First class, Golding flavour" (Factor A); "a good flavour, I like this hop" (Factor B); "nice thick hop, good flavour and good rub" (Factor D).

Ref. No. T 111.—Fairly vigorous and fruitful; hop large, green. Late to mid-season.

"Good, but not choice flavour" (Factor A); "flavour all right, but hop not an improvement on the Canterbury Whitebine" (Factor B).

Ref. No. W 10.—Vigorous and very fruitful.

"A better flavour than that of Y 6; would pass as a Golding flavour" (Factor A); "an inferior hop" (Factor B); "good quality, fair flavour and fair rub" (Factor D).

Ref. No. Y 6.—Fairly vigorous and fruitful.

"Common, not choice flavour" (Factor A); "nothing in it" (Factor B).

Ref. No. I 33.—(Canterbury Whitebine × English male hop.) Vigorous and fruitful; hop of medium size, green, thickly set on laterals; laterals long.

"Genuine Golding flavour" (Factor A); "Golding

flavour, a nice hop" (Factor B); "fair quality, pleasant, but weak flavour; poor rub" (Factor D).

Ref. No. 19.—(Fuggles × red-bined English male hop.)—Vigorous, not very fruitful; bine green, or mottled or striped with red; laterals of medium length, fruitful; hop small, rounded (totally unlike that of Fuggles).

"Nice flavour, a good hop" (Factor B).

Ref. No. X 1.—Seedling of *Ref. No.* 53 (Early White × English male hop).—Vigorous and fruitful.

"Flavour all right, but poor condition" (Factor A). "nothing in it" (Factor B).

Ref. No. G 24.—(Colegate × English male hop.)—Very vigorous and very fruitful; green bine; late hop.

"Very good flavour,—not Colegate flavour" (Factor A); "intensely strong Colegate flavour; a good hop" (Factor B); "good quality, very good strong flavour; good rub" (Factor D).

Ref. Nos. 276, K 44, M 40, M 45, M 49, M 52, N 5, N 15.—(Seedlings of Oregon "Cluster" (*Ref. Nos.* F 19, F 20).)

Ref. No. 276.—Fairly vigorous and fruitful; hop green, close and buttony; *small.*

"Decided Oregon flavour, but weaker than that of *Ref. No.* F 19" (Factor A); "strong Oregon flavour" (Factor B); "nice whole hop, good flavour, good rub" (Factor D).

Ref. No. K 44.—Not very vigorous or fruitful; hop green, small, close and buttony. Late.

"Mild flavour, no Oregon flavour, a nice 'buttony' little hop, but not very promising" (Factor B); "apparently over-ripe; poor flavour; dry rub" (Factor D).

Ref. No. M 40.—Vigorous and fairly fruitful; hop green, very compact. Late.

"Very nice flavour; no Oregon flavour about it" (Factor A); "mild flavour, no Oregon flavour about it; I like this hop" (Factor B); "good quality, resembling the Continental; good flavour and very good rub" (Factor D).

Ref. No. M 45.—Vigorous, fairly fruitful, "white bine," large vine-like leaves, solid, rather pointed hop, clustered. Late.

"Condition first class and flavour excellent, a twang

just apparent in the flavour, but nothing to matter" (Factor A); "a good *distinctive* flavour, no Oregon flavour about it; equal to N 5" (Factor B); "Good, thick hop, good flavour, and very good rub,—appears to be a valuable hop" (Factor D).

Ref. No. M 49.—Vigorous and fruitful; hop large, compact, pointed, sometimes leafy. Late.

A *monoecious* hop, *i.e.*, bearing both male and female flowers (hops) *on the same bine.* Only a few male flowers are produced, and a fair crop of hops.

"Flavour quite good" (Factor A); "a *good* flavour, though the Oregon flavour can just be detected, but nothing to matter; texture of hop bad" (Factor B); "useful stout hop, good flavour, fair rub" (Factor D).

Ref. No. M 52.—Very vigorous and fruitful; hop green, pointed, very solid and compact. Late.

"Has the original Oregon flavour" (Factor A); "strong Oregon flavour; pretty hop,—of promise" (Factor B); "good quality; *mild* Oregon flavour, good rub; appears to be a valuable hop" (Factor D).

Ref. No. N 5.—Very vigorous and fruitful; large green hop, clustered. Late.

"Good Golding flavour; no trace whatever of Oregon flavour" (Factor A).

"Very good hop, good flavour, with no trace of Oregon in it; shows marked promise,—should be tested in brewing trials" (Factor B); "good thick hop of Golding appearance, very good flavour, good rub—appears to be a valuable hop" (Factor D).

Ref. No. N 15. Vigorous and very fruitful, hop inclined towards the "fly-away" Oregon type. Late.

"Nearer the Oregon flavour" (Factor A); "distinct Oregon flavour, but mild (not pungent as in *Ref. No.* F 19), may be of promise" (Factor B); "good thick soft hop, good flavour, good rub" (Factor D).

Ref. No. K. 2.—Canterbury Whitebine × Oregon male hop (*Ref. No.* C 4). Vigorous and fruitful; hop of Oregon, "flyaway" type. Very late.

"A mild and peculiar 'fruity' flavour, not a good hop flavour, certainly no trace of Oregon flavour in it"

(Factor A); "no Oregon flavour, good flavour and would pass for Golding" (Factor B); "poor quality, peculiar flavour, poor rub" (Factor D).

Ref. No. K 11.—Canterbury Whitebine × Oregon male hop (*Ref. No.* E 11.)—Very vigorous; fairly fruitful, hop compact, not of Oregon type. Very late.

"The same as K 2" (Factors A and B); "poor quality, poor flavour, poor rub" (Factor D).

Ref. No. K 22.—Canterbury Whitebine × Oregon male hop (*Ref. No.* F 9).—Vigorous, fairly fruitful, hop compact, not of Oregon type. Very late.

"Very good Golding flavour" (Factor A); "better than K 2 or K 11; (Factor B); "fair quality, fair flavour, good rub" (Factor D).

CLASS III.—FOREIGN VARIETIES GROWN AT WYE.

Oregon "Cluster," (Ref. No. F 19).

"Has the unaltered Oregon flavour" (Factor A); "has lost the appearance of Oregons, but has the pure unaltered Oregon flavour" (Factor B); "has the American flavour, good rub" (Factor D).

German variety (name unknown; Ref. No. 264-5).

"Not a good flavour" (Factor A); "should pass this as an inferior hop; has the German flavour" (Factor B).

A number of samples of "Seedlings," and also of other varieties of hops kindly supplied by factors and merchants, were analysed in the College Chemical Department, and their soft resins contents determined by the method described in this *Journal*, Vol. XIX, p. 375. No difficulty was experienced in obtaining satisfactory duplicates. The results are given below.

TABLES SHOWING PERCENTAGE OF SOFT RESINS.

CLASS I.—HOPS OF UNKNOWN PARENTAGE; BELIEVED TO BE SEEDLINGS.

Reference No.	A. Per cent.	B. Per cent.	Average. Per cent.
B18	11.40	12.74	12.07

The characteristics of this hop are given under the reference numbers at p. 514.

Class II.—Seedling Hops of Known Parentage.

Reference No.	A. Per cent.	B. Per cent.	Average. Per cent.
J24	14.50	14.31	14.40
Q44	15.64	13.52	14.66
	14.70	14.80	
J29	10.21	9.98	10.09
350	7.04	6.39	6.71
L43	10.45	10.75	10.60
T146	12.70	12.59	12.49
	11.80	12.80	
S74	10.77	10.54	10.65
M24	12.60	12.01	12.30
372	12.69	11.46	12.07
P43	13.43	12.26	12.84
K16	12.45	12.31	12.38
I33	10.35	9.06	9.70
19	10.95	10.69	10.82
276	13.02	13.96	13.49
K44	10.72	11.60	11.16
M40	8.90	9.30	9.10
M45	19.96	20.08	19.68
	19.20	—	
M49*	14.73	14.96	14.84
M52*	12.24	12.66	12.45
N5	7.86	7.85	7.85
N15	15.34	16.14	15.74
K22	15.30	15.18	15.24
G24	11.31	11.94	11.62

The parentage and characteristics of these hops are given under their respective numbers at p. 514.

* Some "lice" present in the hops.

Class III.—English Varieties of Hops.

Name of Variety.	A. Per cent.	B. Per cent.	Average. Per cent.
Canterbury Whitebine (grown at Wye College) ..	11.91	11.43	11.67
*Choicest East Kent Goldings ..	15.98	15.75	15.86
*Choicest Kent Fuggles ..	12.43	11.13	11.78
*Choicest Worcesters ..	12.13	11.31	11.72

Class IV.—German Variety of Hop Grown at Wye College since 1902.

Name of Variety.	A. Per cent.	B. Per cent.	Average. Per cent.
Late variety (name unknown) (*Ref. No.* 264-5)	14.83 15.92	14.08 —	14.94

The characteristics of this hop are given on p. 521.

Class V.—German Variety of Hop Grown in Bavaria.

Name of Variety.	A. Per cent.	B. Per cent.	Average. Per cent.
†Choicest Holledaus ..	14.00	15.37	14.68

Class VI.—American Variety of Hop Grown at Wye College since 1908.

Name of Variety.	A. Per cent.	B. Per cent.	Average. Per cent.
Oregon "Cluster" (*Ref. No.* F19)	9.61	10.11	9.86

The characteristics of this hop are given at p. 521.

* These samples were supplied by Factors and Merchants as illustrating "the best growths of the season."

† This sample was supplied by Merchants as illustrating "the best growth of the year."

CLASS VII.—AMERICAN VARIETIES OF HOP GROWN IN AMERICA.

Name of Variety.	A. Per cent.	B. Per cent.	Average. Per cent.
*Choicest Oregons ..	17.17	17.10	17.13
*Choicest New York States ..	9.84	9.84	9.84

As the above tables show, the season of 1913 was favourable for the production of a high percentage of resins. In one sample of the best growth of English Goldings from Kent, the percentage of soft resins reached 15.86. The sample of choicest Holledaus, grown in Germany, averaged 14.68 per cent., and of choicest Oregons, grown in America, 17.13.

With regard to the samples obtained from the new varieties of hops raised at Wye, the first place is taken by a Seedling (*Ref. No.* M 45), whose hops showed on analysis no less than 19.68 per cent. of soft resins. This percentage is higher than that shown by any sample of English or foreign hops analysed previously at the College,—the two next highest being a sample of Oregon hops, grown in Oregon in 1913, with 17.13 per cent., and a sample of Holledaus, grown in Germany in 1909, with 17.08 per cent. This Seedling is four years old; it was raised from seed collected from a plant of the Oregon "Cluster" hop, kindly supplied from Oregon in 1908 by Messrs. Wigan, Richardson & Co., and since grown in the College hop-garden. The male parent is not precisely known, but is probably one of the various forms of the English male hop. The plant is too young for its characteristics to be judged with certainty; it is a late hop, of vigorous growth, but not very fruitful; it possesses a pale green bine, with large green, divided and almost vine-like leaves; the hops are medium in size, somewhat pointed and remarkably dense. The factors' and merchants' reports as to flavour and "rub" are decidedly encouraging (see p. 519). This new hop will be propagated, and if it continues to show promise a number of

* These samples were supplied by Merchants as illustrating "the best growths of the year."

hills will be grown at the East Malling Research Station, and then " cuts " will be distributed to growers for the purpose of testing its suitability for the various hop-growing soils of Kent, Surrey and Sussex.

Other Seedlings of the same parentage as regards the female parent, show a high resins-content; one plant (*Ref. No.* N 15) yielded 15.74 per cent., another (*Ref. No.* M 49) 14.84 per cent., and a third (*Ref. No.* M 52) 12.45 per cent. The characteristics of these Seedlings are given at p. 519, and their cropping powers will be carefully observed during future seasons. It is interesting to observe that some of the Seedlings of this "cross" produce hops which closely resemble in structure and general appearance those of the female parent, *i.e.*, the Oregon "Cluster," such hops are of an open appearance ("fly-away" type), and cylindrical in shape (see Plate 3); some of the Seedlings, however, bear hops of a totally different type, due, no doubt, to the influence of the male parent; these hops are very close or dense, and often more or less pointed (see Plates 2 and 4).

An important fact has been ascertained with regard to the transmission of the "aroma" or "flavour" of a hop to its Seedlings. The female parent of the eight seedlings, *Ref. Nos.* 276, K 44, M 40, M 45, M 49, M 52, N 5, N 15, is the same, viz., the Oregon " Cluster " variety. This Oregon hop, obtained in 1908 from Oregon, and grown since then at Wye, has produced hops year after year which possess the strong " Oregon " or " black currant " flavour, so characteristic of this variety when grown in Oregon. Some of the Seedlings, viz., *Ref. Nos.* 276, M 52, M 49, N 15, have inherited this flavour, either apparently unaltered, as in *Ref. Nos.* 267 and *M* 52, or more or less modified, as in *Ref. Nos.* M 49 and N 15; other Seedlings, however, *e.g.*, *Ref. Nos.* K 44, M 40, M 45, N 5, produce hops which show no trace whatever of the Oregon parentage as regards their aroma,—this in the case of one Seedling (*Ref. No.* N 5) being described as that of the Golding. It is clear, then, that in this " cross " the male parent has had a marked effect in determining the aroma in some of the Seedlings.

Another hop of high resins-contents is the Seedling (*Ref. No.* K 22), with 15.24 per cent. of soft resins. This plant

is of the parentage Canterbury Whitebine, crossed with an Oregon male hop (*Ref. No.* F 9). The plant is only fairly fruitful, and is very late. It is decidedly of interest to find that the use of not only the *female* Oregon hop, but also of the *male* Oregon hop, results in the production of plants with high resins-contents.

The next highest in resins is a late German variety (*Ref. No.* 264-5) (name unknown) which has been grown at Wye since 1902; the percentage here of soft resins was 14.94 per cent. This variety produces season after season a crop with high resins contents, and on this account seems worthy, in spite of the poor report it receives as to flavour, of an extended trial; hills are therefore being planted at the Research Station.

The next highest in resins are two Seedlings (*Ref. Nos.* Q 44 and J 24), with 14.66 per cent. and 14.40 per cent. respectively. Both these plants were raised in 1909 from the same parentage, viz., the German variety Stirn (the earliest hop grown at Wye) and an early-flowering English male hop (*Ref. No.* Z 12). The reports as to the flavour of these hops are satisfactory, and if their cropping powers prove good, these Seedlings will be distributed for testing on various soils where a new early hop is wanted.

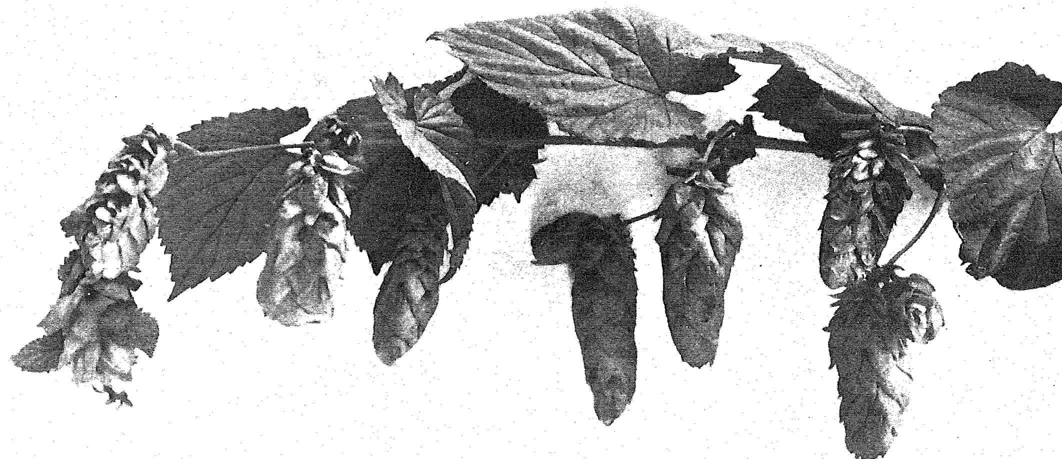
The next highest is the Seedling *Ref. No.* P 43, with 12.84 per cent. of soft resins. This plant appears to be a true "white-bine," with hops of good flavour, and it shows generally considerable promise.

The next hop is the Seedling, *Ref. No.* T 146, with 12.49 per cent.; this plant, which is an early hop, has Saaz "blood" in it, being a seedling of a seedling raised from the German Saaz hop. Its hops possess what is apparently a new flavour, and if the plant continues to show promise, a brewing trial will be made of its hops.

The Seedling, *Ref. No.* K 16, raised from the Canterbury Whitebine crossed with a seedling male hop of English parentage, showed 12.38 per cent.; its hops possess the Golding flavour. The cropping power will now be tested.

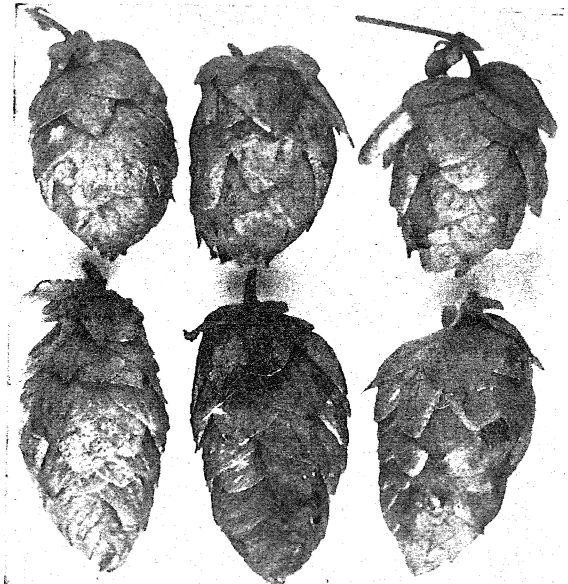
Another Seedling (*Ref. No.* M 24) showed 12.30 per cent. This plant was raised from the German variety, "Upper Bavarian." Its hops received a doubtful report on the

PLATE I.



A branch of the new Seedling hop, Ref. No. J29. (See p. 511). [W. H. Hammond, photo.

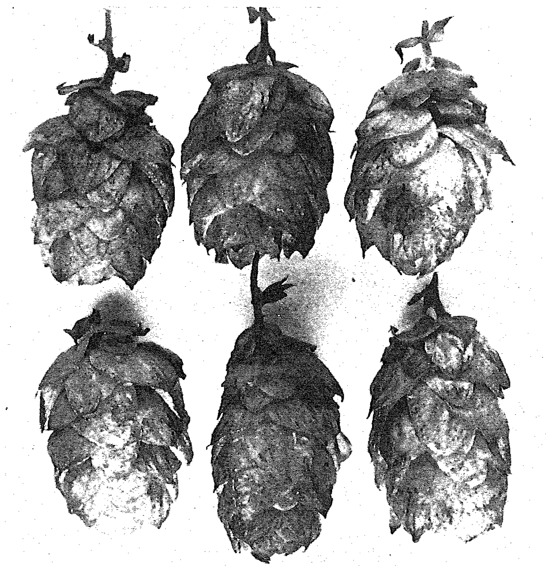
Plate II.



[W. H. Hammond, photo.

Hops (natural size) of a Seedling (Ref. No. M52) of the Oregon "Cluster" (see p. 525).

Plate III.



[W. H. Hammond, photo.

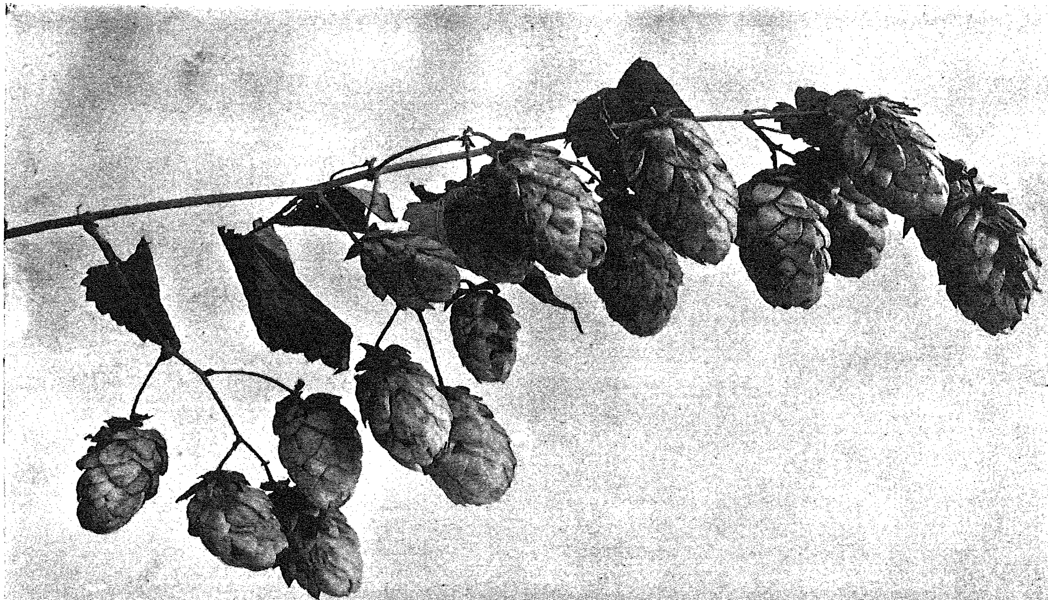
Hops (natural size) of the Oregon "Cluster" grown at Wye since 1908 (see p. 525).

PLATE IV.

[W. H. Hammond, photo.

Branch of Hops of a Seedling (Ref. No. M52) of the Oregon "Cluster" (see p. 525).

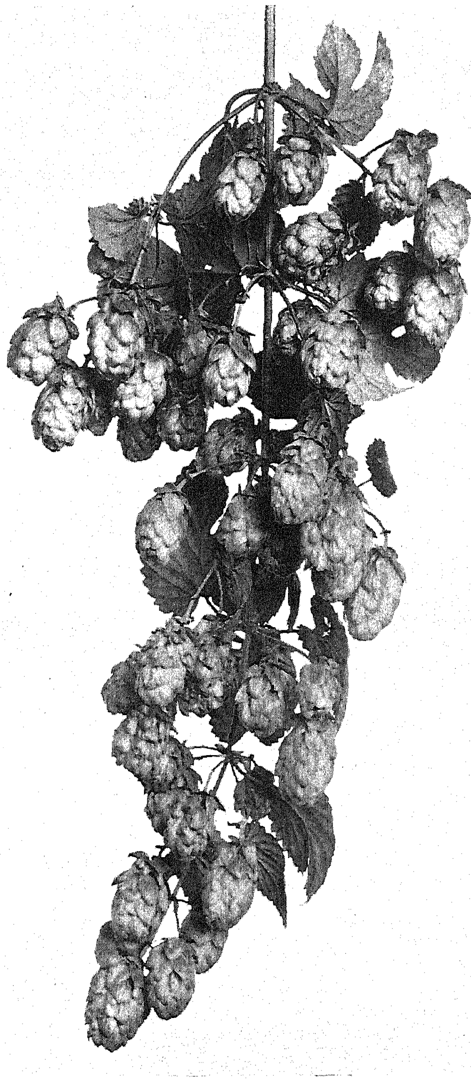
PLATE V.



[W. H. Hammond, photo.

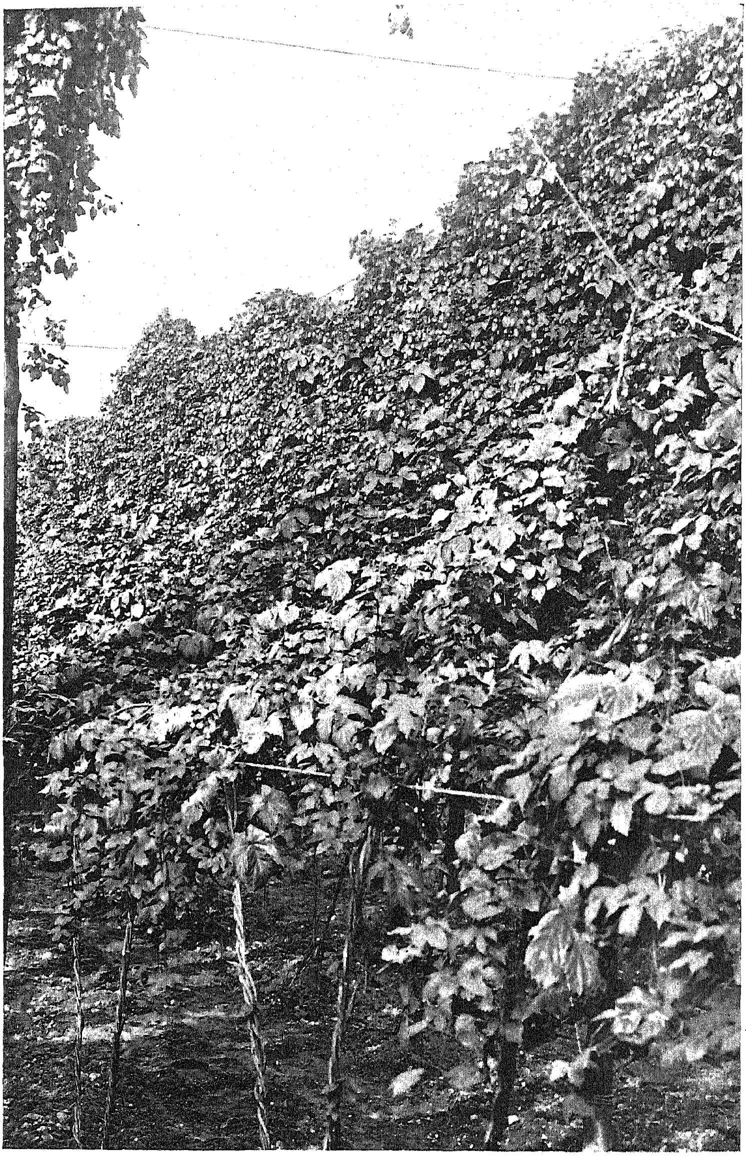
A branch of the " Foundling," a new hop (see p. 529).

PLATE VI.



[H. Wormald. photo.

A branch of the "Foundling," a new hop (see p. 529).

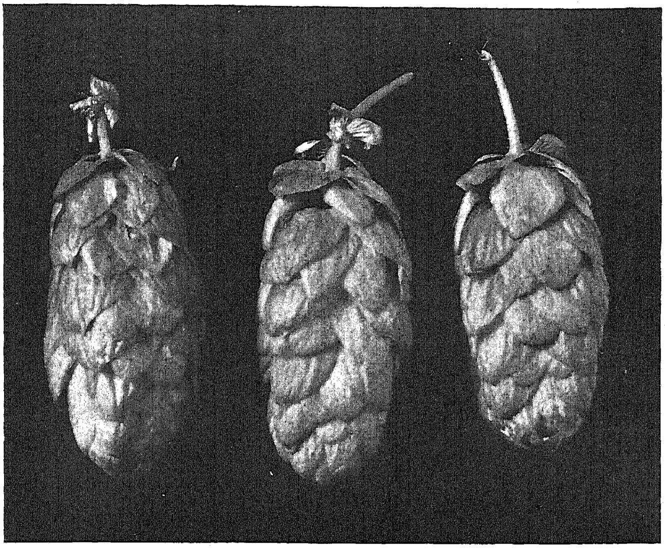


Photograph of a part of the row of the "Foundling" hop in the College Hop-Garden. This is a new hop which shows a marked resistance to the "eelworm disease" or "nettle-head" (see p. 529).

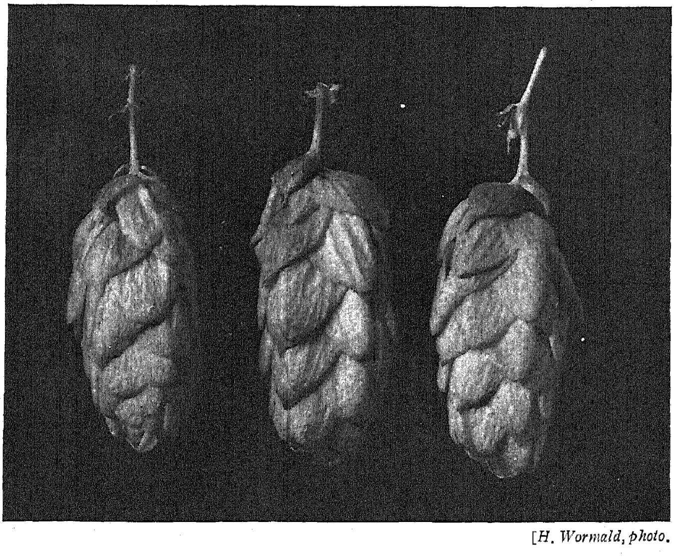
Plate VIII.

A branch of the "Colegate" hop. [H. Wormald, photo.

PLATE IX.



[H. Wormald, photo.



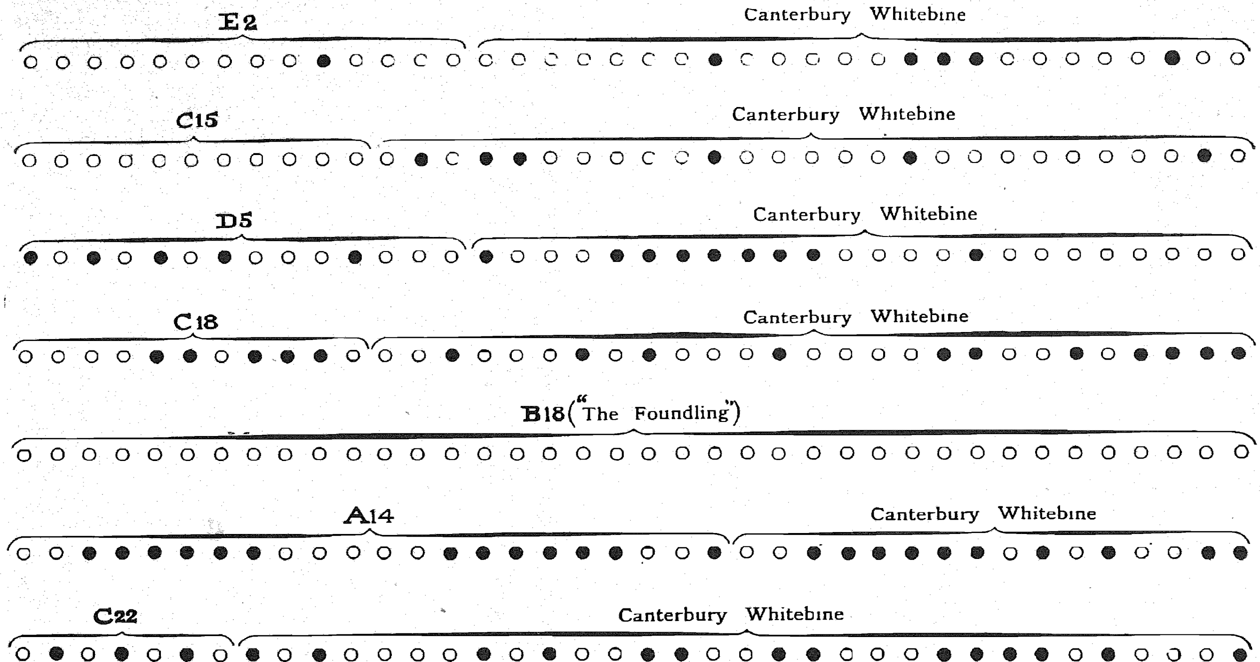
[H. Wormald, photo.

Hops (natural size) :—above, the " Foundling" ; below, the " Colegate."

Borough, but the plant is of interest in that its hops resemble in several respects the best type of German hops.

The Seedling, *Ref. No.* 372, which showed 12.07 per cent., was raised in 1907 from the Fuggles crossed with an English male hop ; it received a good report from the Borough, and a further trial will be made of it.

Lastly the hop, *Ref. No.* B 18, showed 12.07 per cent. This hop is of decided interest apart from its high resins contents, in that so far it has shown a marked resistance to the "eelworm" disease, or "nettle-head." In 1908-9, "cuts" from the original single hill of *Ref. No.* B 18 were planted in the S.W. part of the College hop-garden, forming a row of thirty-six hills. On either side of this row hills (from seven to twenty-two in number) were planted with "cuts" from other varieties of hops (*Ref. Nos.* E 2, C 15, D 5, C 18, A 14, and C 22) in six rows, as shown in the Plan at p. 528, while elsewhere the garden consisted of hills of the Canterbury Whitebine variety. It was soon noticeable that an attack of "eelworm" was developing in this part of the garden, and in 1911 ten hills were destroyed and had to be grubbed, four of these were in the rows adjoining B 18. Notwithstanding that each "eelworm" affected hill was grubbed up completely as soon as the disease was noticeable, the attack increased in virulence during the next two seasons ; in 1912 twenty-eight hills were destroyed, twenty being in the rows adjoining B 18, and in 1913 forty-four hills were destroyed, fifteen being in the rows adjoining B 18. As the Plan at p. 528 shows, not one hill of B 18 has been affected, although the row extends through obviously infected ground. From their position it seemed certain that some at least of the hills of B 18 could not have escaped being attacked by the "eelworm." Mr. C. A. W. Duffield, now engaged in investigating the disease, found on examination that the roots were commonly attacked by "eelworms" in very large numbers. The resistance of B 18 depends then, apparently, not on the roots being unable to be attacked by "eelworms," but on their attack causing no appreciable injury to this variety, whereas in the case of other varieties of hops (*e.g.*, Canterbury Whitebine) such an attack—or even the attack of a fewer number of "eelworms"—soon results in the death of the plant.



Plan of part of the College hop-garden. The black circles indicate the hills killed during 1911–13 by the "eelworm disease." The new hop, "The Foundling," (see p. 529) proved resistant to this disease.

During the past season a very severe infestation of "eel-worm" occurred in several hop gardens near Cranbrook. In some of the worst affected spots "cuts" of B 18 have been planted in order to test further its resistance to eelworm.

The general characteristics of the hop, B 18, are as follows: it is a late hop, being ripe about ten days later than the Canterbury Whitebine. Its growth is very vigorous; the bine, which is green, with blotches (often inconspicuous) of dark green or red, is fruitful; in an average season the crop is about 15 cwt. on the medium hop soil of the College garden. It is little subject to *Aphis* blight, but like most varieties of hop, it is susceptible to "mould." The hops are medium in size, and thickly set on the laterals. Photographs of a part of the row of this variety in the College hop garden, and also of separate hops are shown in Plates 5, 6, 7, and 9.

With regard to the flavour, the reports of hop factors and merchants in the Borough have been as follows:—1907 (box sample), "Good flavour" (Factor E). 1910, twenty bushels of hops were picked from thirty-five hills, planted from "cuts" in 1908-9; they were dried separately and put into a pocket. An ordinary commercial sample was cut from the pocket, and received the following reports:—"Comes below Canterbury Whitebine; lacks refinement and has ranker flavour; has more rub than a Cobb's Golding, and is decidedly superior to that" (Factor A); "is not a Golding, has rank flavour, which is the Colegate flavour pure and simple; should not be grown" (Factor B); "of *full* flavour, *not rank*—worth going on with" (Factor D). 1911, forty and a half bushels of hops were picked from thirty-five hills, dried separately and put into a pocket. An ordinary commercial sample received the following reports:—"Is not a true Colegate, but has a ranker flavour—probably belongs to the Colegate class" (Factor A); "a very nice flavour, inclined to the Colegate; a good hop" (Factor B); "has strong but *not coarse* flavour" (Factor D). 1912 (box sample): "Quite good, mild flavour" (Factor A). 1913 (box sample): "Very nice flavour, should say was as good a hop as Fuggles" (Factor A); "poor in colour; good mild flavour, fair rub" (Factor D).

Chemical analyses to ascertain the percentage of soft

resins have been made during the past three seasons both of B 18 and of the adjoining Canterbury Whitebines ; these figures are as follows :—

B 18.				Canterbury Whitebine.			
	A. Per cent.	B. Per cent.	Average. Per cent.		A. Per cent.	B. Per cent.	Average. Per cent.
1910 ..	10.51	8.98	**9 75**	1910 ..	10.63	10.42	**10.53**
				1910 ..	10.29	9.33	**9.81**
1911 ..	9.78	10.48	**10 13**	1911 ..	9.55	9.70	**9 63**
1913 ..	11.40	12.74	**12.07**	1913 ..	11.91	11.43	**11.67**

Brewing trials of B 18 were made in 1910 and 1911 at two different Breweries. The first Brewery reported that the results in a bitter beer were not quite satisfactory; it was suggested that the hops would no doubt go well in Lager beer ; and the opinion was expressed that if the variety of hop was a "cropper," it would, on account of its richness in resins, pay to grow. The second Brewery reported that the hops, on analysis, came second in resins of all hops tested that season, and could be considered quite up to the average of the year's hops in preservative value ; further, that though not a bright looking sample, the hops were well grown out, and of a thick appearance. In the brewing trials the flavour was not considered delicate enough for Pale Ale ; the opinion was expressed that the hop might be useful to replace foreign hops in those breweries where the latter are used.

B 18 is one of a certain number of hops growing in the College experimental hop-garden, of which no record as to origin were available when I took charge in 1906 of the work of raising new varieties from seed. The plant is believed to be of seedling origin, and in some respects it resembles the Colegate variety, though it is clearly quite distinct from that. Its characteristics, and also its differences from the Colegate, can be seen on referring to Plates 5 to 9. I have not been able to identify B 18 with any variety at

present cultivated, and propose to name it "The Foundling." Cuts and rooted sets to the number of 2,709 have been supplied during the past few seasons to a number of hop-growers in the following parishes—*Kent:* Paddock Wood, Wickham, Woodnesborough, Brenchley, Marden, Wateringbury, Canterbury, Faversham, Cranbrook, Barming, Yalding, East Peckham, Goudhurst, Horton Kirby, Leigh; *Sussex:* Bodiam, Battle, Ticehurst, Uckfield. It will therefore soon be possible to report as to the value of this new hop for cultivation on different soils.

Any hop-grower in Kent, Surrey or Sussex who wishes for "cuts" of "The Foundling" in order to test its value as a late hop rich in resins or its eelworm-resisting powers, should apply before November in any year.

The sending out of Male Hops to Growers in Kent, Surrey and Sussex.

As the result of information sent out by Wye College during the past ten years as to the great practical value of planting up the right kind of male hops, an increasing number of applications are received annually for "cuts" of male hops selected for vigour and for early—or late—flowering

In 1913 the weather at the time when many hops were in "burr" was damp and cool; in consequence there was little pollen from the male hops carried any considerable distance, with the result that in many gardens only those hops which were within a certain distance of a male hop received pollen on their "burr," and developed large well grown-out hops. In other words, in a season like 1913, with dull, cool weather at the time when hops are in "burr," the hops are dependent for fertilization (and the resultant "growing-out" of their hops) on the male hops *growing in that garden;* whereas in hot, dry summers a greater or less amount of pollen is carried on the wind into most gardens from male hops growing elsewhere. The fact that hops grew out well in 1913 only in the neighbourhood of male hops was especially noticeable in the case of Bramlings, where the practice has been generally followed of grubbing up all male hops. We have received many applications this season for "cuts" of male hops suitable for planting with Bramlings.

During the winter of 1913-14, the number of applications for male hops was ninety-one. The requirements of seventy-six growers were able to be satisfied, by sending out 3,078 "cuts" from the male hills now cultivated at the College. The remaining fifteen growers have been placed on the waiting list for next season. The "cuts" were sent to growers in the following districts:—*Kent*: Sevenoaks, Harbledown, Five Oaks Green, Ash, Hawkhurst, Tonbridge, Biddenden, Marden, Barming, Woodnesborough, Cranbrook, Dover, Selling, Wateringbury, Headcorn, Staplehurst, Hadlow, East Malling, Littlebourne, West Malling, Chatham, Bethersden, Sutton Valence, Goudhurst, Ulcombe, Faversham, Otham, Wittersham, Woodchurch, Rolvenden, Goodnestone, Kenardington, Throwley, Paddock Wood, Sittingbourne, Yalding, Horton Kirby, Penshurst and Smarden. *Sussex*: Mayfield, Bodiam, Etchingham, Beckley, Udimore, Battle, Northiam, Pett, Burwash, Withyham, Northiam, Sedlescombe, Tunbridge Wells, Five Ashes and Hadlow Down. *Surrey*: Farnham.

Hop growers who intend to apply for male hops should note the period during which the hops among which the males are to be planted remain in "burr." If this information is sent to Wye College "cuts" of exactly suitable male hops will be supplied.

VETERINARY NOTES

BY

T. W. CAVE, F.R.C.V.S.

PREVENTION OF WHITE SCOUR IN CALVES.

Contagious Gastro-enteritis of Calves. This is a specific disease, in which the marked symptom is a whitish or grey fœtid diarrhœa, which affects calves during the first few days after birth. The disease is practically confined to new-born calves, and it is enzootic in various parts of the British Isles and on the Continent.

Cause.—On this point there is a considerable difference of opinion. Some authorities affirm that the disease is due to one or more types of organisms of the coli group, and that infection mainly takes place through the mouth. On the other hand, others declare the disease to be due to a pasteurella organism, allied to the pasteurella organism causing Fowl Cholera, and that infection occurs through the navel-string, through the freshly ruptured umbilical vein and before the wound has healed. The result of treatment finally adopted at the College Farm bore out this latter theory.

It is, however, very probable that White Scour may be produced by either of these groups, although in the healthy adult animal the coli organism does not injure the intestinal mucous membrane, yet it is quite possible that this organism could infect the delicate intestinal mucous membrane of the new-born calf, and bring about inflammation and scouring.

The disease is very fatal. The mortality varies from 70 per cent. to 100 per cent., according to the virulence of the organism.

It has been said that animals which recover from White Scour later succumb to lung disease.

The Period of Incubation (*i.e.*, the time which elapses between the time of infection and the first symptoms) is exceedingly short, sometimes only a few hours, in some cases

calves begin to scour almost immediately after birth, and succumb within twenty-four hours.

Symptoms.—A very high temperature, 105°F. to 107°F., accompanied or soon followed by a very liquid diarrhœa, greyish or white in colour, usually very fœtid and sometimes blood-stained. The calf does not feed well, refuses milk and frequently grunts and moans. The back becomes arched and soon animal staggers about, afterwards is unable to stand and becomes very much emaciated. The temperature becomes sub-normal and the extremities cold, and the animal finally dies. Arthritis (*i.e.*, inflammation of the joints) is a common complication, especially of the hock joints, the joint becomes hot, swollen and painful, and animal refuses to put weight on the limb.

Lung complications are also fairly common, and when present the symptoms are those of pneumonia.

The animal sometimes dies in a few hours of an acute septicæmia, before showing any symptoms of diarrhœa, but the disease usually lasts from three to eight days.

Post-mortem Appearances.—The disease is a septicæmia. The umbilicus is usually enlarged and the umbilical vein contains a clot which is easily broken down. There is practically always an intense Gastro-enteritis, the Pyloric portion of the abomasum being often the only portion of the stomach affected.

Treatment.—Curative Treatment is usually of no avail, but the common astringent remedies may be tried after a dose of castor oil has been first given. Then follow with brandy and starch gruel and laudanum, in following proportion :—one teaspoonful laudanum, one tablespoonful of brandy and a tea cupful of made starch. This is to be given three times a day.

Calves Cordial may also be tried.

Preventive Treatment.—The best treatment to adopt is to take stringent preventive measures. The primary cause of this disease is filth, and the organisms live in filth. The old common practice of rearing calves in any dark, ill-ventilated and unclean shed must be regarded as highly dangerous. Well-lighted sheds, with good ventilation and sound impervious floors are to be recommended.

Where the disease exists, cleansing of the shed with efficient disinfection should be first carried out, and perfect cleanliness must be insisted upon. This treatment alone should be effective in an outbreak due to the coli group of organisms, which enter by the mouth.

With the pasteurella group other measures must be adopted. The navel-string should be tied securely immediately after birth, and then treated with iodised-phenol. This powerful disinfectant should be applied with a camel-hair brush to the navel-string only, and not to the surrounding skin. The ligature should be tied one inch to one-and-a-half inches from the belly. For the ligature very narrow white tape should be used. It is a good plan to keep a skein of tape immersed in 95 per cent. carbolic acid in a wide-mouthed bottle, a sufficient length of tape can be drawn out when required and cut off with scissors. This treatment should be applied to every new-born calf.

In a recent outbreak at the College Farm ten calves were affected, three of these died before treatment could be applied, of the remaining seven, five died and two recovered, the curative treatment before mentioned being adopted. The preventive treatment above described was put into operation, and for four months no further outbreak has occurred, but one rather interesting fact may be mentioned. The tying of the navel string was in one case forgotten, and that animal developed severe scour within three days.

It is a good plan to make a practice of ligaturing the navel in foals and calves, as it is a very useful preventive also against "Joint Ill," and will very well repay the little extra trouble required.

BLACK HEAD.

Is a disease of young turkeys, which is unfortunately often met with and which seems to be unrecognized even by experienced bird-keepers. The young birds between the ages of two weeks to three or four months are affected with diarrhœa and weakness.

Sometimes there is a discoloration of the head, which gives the common name to the disease. Nearly all affected birds die sooner or later, but in some it assumes a chronic form, which may last many months.

The disease is known to be due to the invasion of the large intestine, especially the cæca, by a protozoon parasite, which is usually picked up with the food. The parasite invades the walls of the cæca, causing them to be inflamed and thickened; later the parasite is carried, probably by the circulation, to the liver, in which now appear greyish-white patches, giving that organ a spotted appearance.

On post mortem examination, one or both cæca are found to be enlarged and inflamed, with thickened walls and filled with a hard cheese-like mass. The liver in some cases is more or less enlarged and shows greyish or yellow spots. Definite diagnosis may be arrived at by making a smear from the mucous membrane lining the cæcum, which with suitable staining shows the protozoon organism, sometimes in great numbers.

Treatment of the ailing birds may be tried, and sulphate of iron 10 grains in a gallon of drinking water is recommended.

Aperient medicine, as Epsom salts or castor oil, should also be given.

The treatment of a large number of ailing birds is not likely to meet with much success, and the efforts of the owner should rather be directed to preventive measures. Frequent changes

of ground are necessary, and the soiled runs should be well sprinkled with lime. All pens, drinking troughs, incubators, etc., should be thoroughly cleansed and disinfected. As the parasite may be introduced by purchased eggs, which are used for incubation, it has been suggested that each egg should be wiped with an 80 per cent. solution of alcohol before being placed in the incubator, or under the hen. Some have imagined that the parasite may live inside the egg, but it is far more reasonable to suppose that the egg-shell is soiled with infected fæcal matter.

Where only a small number of birds are kept, it would be advisable to kill and burn all the carcases, but this course can hardly be recommended to the large breeder.

NOTES ON THE LIFE HISTORIES OF SOME NEMATODES PARASITIC IN THE ALIMENTARY CANAL OF SHEEP,

WITH SUGGESTIONS FOR THE TREATMENT OF THE ANIMALS SO INFECTED.

By H. E. Hornby, M.R.C.V.S.

This communication deals with the results of observations made at Wye between March, 1912, and September, 1913, during which period a large number of post-mortem examinations were made. Sheep in this district were found to be infected with six species of Nematode worms :—

(*a*) Strongylus contortus (*Hæmonchus contortus* Rudolphi).
(*b*) S. cervicornis (*Ostertagia circumcincta* Stradelmann).
(*c*) S. gracilis (*Trichostrongylus extenuatus* Raillet).
(*d*) S. fillicollis (*Nematodirus fillicollis* Rudolphi).
(*e*) Sclerostomum hypostomum (*Chabertia ovina* Fabricius).
(*f*) Trichocephalus affinis (*Trichuris ovis* Abildgaard).

Positions of the Parasites in the Alimentary Tract.

S. contortus, S. cervicornis and *S. gracilis* occurred most abundantly in the abomasum, or fourth stomach; *S. fillicollis* was found in the small intestine, *Sclerostomum hypostomum* in the colon, and *Trichocephalus affinis* in the cæcum. It is to be noted, however, that specimens sometimes occurred in abnormal situations, thus the small intestine often contained stomach worms when the latter organ was heavily infested, whilst on one occasion a number of specimens of *S. gracilis* were found alive and apparently thriving in the colon.

Relative Importance of the Different Species.

McFadyean, in 1897 (J. Comp. Path. and Therap.), found *Strongylus cervicornis* to be the worm most commonly associated with parasitic gastritis in this country, but *Strongylus contortus* may be of equal economic importance.

In the S.E.A.C. *Journal*, 1912, R. C. Bruce Gardner describes these two species as about equally responsible for outbreaks of disease.

As the result of thirty-six post-mortem examinations in the county of Kent, *Strongylus cervicornis* was found to be the most abundant form, occurring in twenty-two sheep, in ten of these as the only parasite. *Strongylus contortus* occurred in eight, in one case only being the sole species. *Strongylus fillicollis* and *Strongylus gracilis* each occurred in six cases, whilst *Sclerostomum hypostomum* was only recorded once. *Trichocephalus affinis* was found in small numbers in the majority of sheep of which the cæcum was thoroughly examined.

In ten out of the thirty-six cases just referred to, death was caused directly or indirecly by parasitic gastro-enteritis; for three of these deaths *Strongylus cervicornis* was solely responsible, *Strongylus contortus* and *Strongylus fillicollis* were each responsible for one, whilst the other five deaths were caused by a mixed infection of nematodes.

Sclerostomum hypostomum and *Trichocephalus affinis* are probably not often responsible for much damage, Professor Cave has, however, told me of one severe outbreak of enteritis due to the former parasite (200 lambs destroyed). The results of these post-mortems, therefore, show that of the six species, *Strongylus cervicornis* is the most dangerous, *Strongylus contortus* coming next, followed by *Strongylus fillicollis* and *Strongylus gracilis*, and lastly by *Sclerostomum* and *Trichocephalus affinis*.

Observations on the Life History of the Parasites.

Certain observers have stated that in some of these parasites the whole life-cycle may take place in the body of the host and claim to have found every stage from egg to adult worm in infected stomachs. My observations lead to quite opposite conclusions.

It is obvious that if development can proceed unchecked by any necessity for an existence outside the host, then infection in a sheep must continually increase, whether the animal be removed from fresh sources of infection or not.

This is certainly not the case; my experience is that in every instance in which sheep were brought from infected pastures on to arable land or into a stable, then, slowly but surely, the egg out-put, by which infection can be gauged, decreased until at the end of a few months it was practically nil.

These observations showed the necessity of studying the development of the eggs outside the body of the host. This was done in two ways: the first method adopted consisted in collecting fæces from infected sheep, and making "cultures" of these in the laboratory; the second in obtaining eggs direct from the uterus of a worm, and observing them in a suitable medium.

The "cultures" of fæces were kept moist in small dishes at laboratory temperatures, samples being taken from time to time and examined on a slide under the microscope. The eggs of *Strongylus fillicollis* and *Trichocephalus affinis* are easily identified by their size and shape; it is, however, impossible to distinguish between those of *Strongylus contortus*, *Strongylus cervicornis*, *Strongylus gracilis* and *Sclerostomum hypostomum*; it was therefore hoped that the larvæ would furnish distinguishing characters. As a matter of fact, the development of the individuals of these genera must be remarkably similar, for the same types of larval forms were found in all cultures which had contained eggs of this type. Generally speaking, development proceeded as follows:— After four to five days the embryos left the eggs as small active larvæ .3 to .4 mm. long, with pointed tails, and provided with an œsophagus furnished with a posterior bulbous swelling. These "bulbed" larvæ increased in size rapidly until after eight to ten days they had reached a length of .5 to .6 mm. At this stage feeding ceased, the œsophageal bulb disappeared and the larvæ acquired sheaths. The ensheathed larvæ are very active and resist a considerable amount of desiccation.

This life history is practically identical with that of

Strongylus contortus, as described by Ransom (U.S. Dept. of Agriculture, Bureau of Animal Industry, Circular 93); this observer was able to show that under certain conditions the ensheathed larvæ are able to crawl up and come to rest on blades of grass, thus being swallowed by sheep and other ruminants.

The observations recorded above lead me to consider that the development of *Strongylus cervicornis*, *Strongylus gracilis* and *Sclerostomum hypostomum* must proceed on much the same lines as that of *Strongylus contortus*.

As mentioned above, in order to test these conclusions, an attempt was made to prepare pure cultures from the eggs of the different forms. All six species were experimented with, and although the investigations were never completed it may be of interest to record some of the results.

For most cases the method adopted was briefly as follows: Several mature females of the species to be investigated were transferred to a watch-glass full of clean water and thoroughly washed, these were then carefully broken up in water so as to liberate the eggs, and a drop of the " emulsion " so obtained added to a small quantity of boiled fæces in a live-box.

Sclerostomum hypostomum.—The eggs as thus obtained measured 85-90 $\mu \times$ about .50 μ and were mostly in a state of multiple segmentation. After two days, several larvæ .45 mm. long and with a maximum breadth of 30 μ had emerged, they showed well-defined œsophageal bulbs. Seven days later these larvæ had grown to a length of .6 mm., a few retain the bulb, but in the majority this organ had been lost and a distinct sheath could be demonstrated.

Strongylus cervicornis.—The eggs measured 75-90 $\mu \times$ 40-50 μ, nearly all were unsegmented. After four days larvæ emerged .35 mm. long, provided with pointed tails and bulbs to the œsophagus. Two days later these larvæ had grown to a length of .5 mm. and still retained the œsophageal bulbs. At this stage the cultures had unfortunately to be abandoned.

Strongylus gracilis.—All attempts to hatch the eggs of this species failed. The eggs measure 70-80 μ in length by 35-45 μ in width.

Strongylus fillicollis.—The eggs of this species are very characteristic, owing to their large size; they measure 160-200 μ

in length. A striking feature is their slow rate of development in ordinary cultures, months often passing before the segmenting ovum is replaced by a larvæ within the egg capsule. Even when fully developed, hatching rarely takes place in moist cultures, and eggs containing larvæ have been found in such cultures kept in the laboratory for more than ten months. Strange to say, a moderate amount of desiccation, sufficient to kill the eggs of any of the other sheep nematodes, seems to favour both the development and hatching out of the larvæ; the only free larvæ obtained were those from cultures of fæces which had been allowed to dry at room temperature for periods varying from one to several weeks.

The hatched larvæ of *Strongylus fillicollis*, .55 mm. and upwards in length, are characterized by the relatively enormous length of the whip-like tail; they possess a filariform œsophagus (*i.e.*, one without a bulb) and are already ensheathed when they hatch out, being thus unable to feed or grow. These ensheathed larvæ withstand desiccation for several days and are very resistant to chemical reagents.

Trichocephalus affinis.—The eggs of this worm are quite typical, about 70 μ long, brown in colour and lemon-shaped, being provided with an operculum at each end. Previous investigations have demonstrated that free-living stages do not occur, the larvæ hatching only when the eggs are swallowed by sheep or other ruminants.

Attempts were also made to trace the later stage of development in the alimentary tract of the host, such stages were, however, rarely met with, nearly all the worms seen in this position being already sexually mature, this is due, no doubt, partly to the difficulty in finding the tiny larvæ among the stomach contents, and partly to the rapidity of their development within the alimentary tract.

Immature worms were, however, found on a few occasions, both in the stomach and small intestine; these varied in length between 1.3 and 3 mm., and in several cases showed rudiments of the spicules and bursa. The smallest specimen provided with a bursa was obtained from the stomach of a ewe and measured 1.8 mm. in length.

It was, unfortunately, impossible to identify any of these forms.

PARASITIC GASTRITIS AND ENTERITIS OF SHEEP.

A FEW REMARKS, AND AN ACCOUNT OF SOME EXPERIMENTS, ON THE TREATMENT.

Two great classes of worms have been held responsible for severe and often fatal diarrhœa in sheep. These are the *cestodes*, or tapeworms, and the *nematodes*, or round worms.

Treatment of Tapeworm disease.—We have found this to be a comparatively simple matter. We have experimented with a large number of drugs, including areca nut, male-fern, turpentine, eucalyptus, arsenic, creosote, lysol and others, and have evolved the following mixture, which we have found during two seasons to be absolutely satisfactory as a tæniafuge, and, at the same time, useful to a less extent for destroying nematodes :

℞	Extract of Male Fern	7 oz.
	Oil of Turpentine	7 oz.
	Tinct. asafætida	7 oz.
	Creosote	5 drams.
	Raw Linseed Oil	1 qt.

§ One tablespoonful to be given, and repeated in three days.

TREATMENT OF STRONGYLOSIS, OR PARASITIC GASTRO-ENTERITIS DUE TO NEMATODES.

To ascertain the effects of a drug on the parasitic nematodes' various lines may be pursued :—

(1) One may watch the clinical symptoms for signs of abatement.

(2) One may test the effects of a known solution of the drug on the living worms " in vitro."

(3) One may make a series of examinations of the sheep's fæces before and after the dosing to see if any marked diminution in the output of eggs occur.

None of these methods is absolutely satisfactory, the first and third because they ignore the vis medicatrix naturæ which is acting continually, and the second because outside the body the adult worms will not live long even in normal saline solution at body temperature, and so it is not always easy to say that a certain drug has been the cause of death, nor, even when a number of controls live and only the treated ones die, is it possible to say that the drug in question would have the same effect on the worms in their natural habitat.

It is on the strength of the first method that the majority of worm medicines have obtained their reputations. A number of animals are ill; post-mortem examinations of those which die reveal worms to be the causal agents; certain drugs are given to those yet alive; a few more die, but the rest recover; the drug is set down as being the cause of recovery. It may have been, or on the other hand recovery would possibly have taken place if no drug had been given, for, as we have mentioned elsewhere, parasitic gastro-enteritis, even when untreated, never causes death of the whole of the flock; some, generally the majority, recover. On the other hand if on several occasions the administration of a drug has been followed by marked improvement on the animal's part, then the drug should be given the benefit of the doubt and used until it has been proved to be useless. If, again, the administration of a drug to several affected animals be in no case followed by any abatement of symptoms, then that particular drug in that dose in that particular locality can be set down as being inefficacious.

The second method of testing the efficacy of drugs was adopted by Sir J. McFadyean and reported on in the *Journal* of the Royal Agricultural Society, 1897, and if this be a reliable method of testing drugs, then, amongst others, Turpentine, Carbolic Acid, Chloroform, Fowler's Solution of Arsenic

in ordinary doses are of little or no use. As a result of his experiments, he recommends a 1 per cent. solution of Lysol as forming the most suitable remedy.

The third method, with modifications, has been the one employed by Dr. Theiler in carrying out his classical experiment with Arsenic, Cooper's Dip, and Bluestone, as the result of which he recommends that 5 grains of Cooper's Dip and 5 grains of Bluestone (copper sulphate) be a safe and useful treatment for affected lambs, and double the quantity of each for adult sheep. (See *Agricultural Journal*, Union of S. A., March and August, 1912).

Ransom (Circular 102, United States Department of Agriculture) has recommended 1 per cent. solution of coal-tar creosote (2 to 4 ounces), or gasoline (2 to 4 drachms in oil or milk). The same author (Circular 157) also shows that the feeding of tobacco had no noticeable effect either on the worms or the sheep.

Brumpte and Caucurte (Bul. Soc. Acclim., France, 59, 1912), found that coal-tar creosote (½ per cent. solution), copper sulphate (1-1000) and iron sulphate (1-1000) were ineffective as preventives.

Our own experiments have been controlled by methods one and three. For examining fæces for ova we were originally content to simply moisten the fæces with water and then make several smears, as thick as was consistent with transparency, and then to state the number of eggs in terms of "few" or "many." Such a method is of no use unless the same worker examine all the smears, as the terms "few" "numerous" or "many" have no standard value, but a person who examines some dozens of smears daily, as has been our usage, soon has a mental standard with which he compares all his smears and then his estimate of the number of ova present has a very real value.

Dosing with Coal-Tar Creosote.

We have stated that whereas Brumpte and Caucurte found ½ per cent. coal-tar creosote ineffective as a preventive, yet Ransom recommends a 1 per cent. solution as a fairly efficient cure.

(In all our experiments, unless otherwise stated, the dosing has been done in the morning on an empty stomach.)

On *September 6th*, we dosed a four month's old Southdown lamb, clinically affected, thin, and with fæces literally packed with eggs, with three ounces of a 1 per cent. solution. He took it well.

On *September 7th*.—Fæces firmer, dark, but full of eggs.

On *September 9th*.—Ditto.

On *September 14th*.—Fæces loose and still full of eggs.

On *September 20th*.—Scouring. Off his feed. Very thirsty. Fæces full of eggs.

On *September 21st*.—We dosed him with five ounces of a 1 per cent. solution. He took it well.

On *September 23rd*.—Eating better, but still scouring. Fæces still full of eggs.

On *September 26th*.—About the same. Fæces firmer, but still containing many eggs.

On *October 3rd*.—We dosed him with eight ounces of 1 per cent. solution (four times the amount recommended by Ransom). After administration he coughed frequently and would not feed for some hours.

On *October 4th*.—Eating fairly well. Fæces loose and full of eggs.

On *October 9th*.—About the same. Coughs frequently.

On *October 15th*.—Ditto.

On *October 20th*.—*In extremis*, lying on his side and refusing all food. Fæces black, liquid and full of eggs.

On *October 21st*.—Died. Post-mortem showed that the abomasum contained an enormous number of both *Strongylus contortus* and *Strongylus cervicornis*. The lungs showed patches of pneumonia.

This series of dosings with coal-tar creosote shows that the drug cannot be depended upon. A larger dose than eight ounces is impracticable, owing to the irritant nature of of the drug and the greater danger, in the event of careless dosing, of setting up bronchitis and pneumonia. A solution of greater strength than 1 per cent. would be too injurious to the buccal mucous membrane.

Dosing with Petrol.

This drug has been used with great success for the expulsion of worms from ostriches; a pint of the undiluted medicine being given; and so we decided to give it a fair trial in the treatment of parasitic gastritis.

On *April* 15*th.*—We dosed a Southdown lamb, six weeks old and scouring badly—fæces loaded with eggs—with one drachm of petrol in four ounces of milk.

On *April* 16*th.*—Scouring diminished, but no diminution of eggs.

On *April* 17*th.*—We gave two drachms of petrol in four ounces of milk.

On *April* 18*th.*—As yesterday, so repeated the dose.

On *April* 19*th.*—No diminution in the number of eggs.

At this stage we had to discontinue the experiment.

On *April* 15*th.*—We dosed an ewe lamb, Southdown, six weeks old, scouring—fæces full of eggs—with one drachm of petrol in four ounces of milk.

On *April* 16*th.*—Diarrhœa drying up, but fæces still full of eggs. Dosed as before.

On *April* 17*th.*—Fæces firmer but egg content unchanged. Administered two drachms of petrol in four ounces of milk.

On *April* 18*th.*—Diarrhœa recommenced, so gave four drachms of petrol in four ounces of milk.

On *April* 19*th.*—Fæces as yesterday, so repeated the dose.

On *April* 20*th.*—Lamb as before, only weaker.

On *April* 22*nd.*—Died, but no post-mortem made.

On *May* 13*th.*—We dosed a Southdown lamb, aged two months and passing numerous strongyle eggs, with four drachms of petrol in three ounces of linseed oil.

On *May* 16*th.*—This lamb died of tetanus, and post-mortem showed numerous *Strongylus cervicornis.*

On *July* 6*th.*—A Southdown ewe showed all the symptoms of pernicious anæmia due to parasites, but on examination of the fæces, which were semi-fluid, showed no eggs. We dosed her with three ounces of petrol in the same quantity of castor oil. She immediately afterwards presented grave

symptoms of vertigo—running backwards, staggering, laboured respiration, thready pulse, head pushed forward with mouth open. These symptoms disappeared in two hours.

This ewe afterwards made a good recovery, but since there was no proof of her having been infected with parasitic-gastritis, the petrol cannot be held responsible. This experiment merely shows that three ounces is a dangerous dose for a sheep.

On *July 8th.*—A Southdown ewe showed signs of acute anæmia. She was in good condition, but fæces were liquid and simply packed with eggs. We drenched her with two ounces of petrol in the same quantity of castor oil. Symptoms similiar to, but graver than those in the case last recorded were set up, and the animal remained prostrated until nightfall, when she died.

On post-mortem there was a distinct smell of petrol in the first and second stomachs, but not in the fourth. (Incidentally this shows, and other experiments have comfirmed, that no drench passes straight through to the abomasum.)

In the fourth stomach we found numerous adult and immature specimens of *Strongylus contortus.*

These experiments with petrol indicate that, even when given in lethal doses, its effect on worms in the fourth stomach is almost negligible.

Dosing with Turpentine.

This is one of the most widely-recommended drugs for the treatment of parasitic gastro-enteritis, although, as stated previously, McFadyean found the adult worms treated *in vitro* to be very resistant to its action.

On *March 20th,* two Hampshire ewes and one Suffolk ewe, which had lambed about a month, were looking very thin and weak. Their fæces were soft but not diarrhæic and showed only a few eggs. We dosed each with one ounce of turpentine in six ounces of linseed oil.

March 26th.—Ewes somewhat brighter in appearance. Fæces of same consistence and no diminution in egg-count.

On *March 28th,* we dosed the same three ewes with one-and-a-half ounces of turpentine in ten ounces of linseed oil. They all took their dose well and were not distressed by it.

April 1st.—Two are scouring (due probably to the medicine). In no case is there a diminished output of eggs.

Without further treatment these sheep progressed, and by the autumn were well and fat.

In the above instances the thinness, etc., were probably due more to the "pulling down" effects of the lambs than to worms, and so the experiment is only interesting in showing that a dose of one-and-a-half ounces is quite safe, and that even that dose had no appreciable effect on such worms as were present.

Dosing with Arsenic.

On *June 29th* a Southdown ewe (2-shear) in very poor condition, but the fæces of which were moderately firm and showing only a few eggs, was dosed with twenty grains of arsenic in eighty grains of saccharose. Previously she was fasted and kept without water for twenty-four hours. After dosing she received a little green food, but no water for another twenty hours.

July 4th.—No diminution of egg-count.

On *August 29th*, a Southdown lamb, about five months old, was very thin, scouring, with fæces that contained numerous eggs. After being kept without food and water for twenty-four hours it received fifteen grains of white arsenic in eighty grains of saccharose.

August 30th.—Still scouring, so we administered two ounces of castor oil.

September 2nd.—Still scouring, and fæces showing little, if any, diminution on the egg output.

These experiments confirm Thieler's as to the safety of giving relatively huge doses of arsenic, but it is extremely doubtful if the drug given as a powder is of much value as a curative agent.

Dosing with Santonin.

On *August 29th*, a Southdown lamb, about five months old, was scouring profusely and the fæces were full of eggs. After being fasted and kept from water for twenty-four hours it received fifteen grains of santonin in eighty grains of saccharose.

August 30th.—Scouring diminished, but little, if any, diminution in the egg output.

September 2nd.—Fæces are now quite firm, but still contain many eggs.

On *September 5th,* a Southdown lamb, about five months old, was passing liquid, yellow fæces, the egg content of which was very high. A noticable feature was the large proportion (nearly fifty per cent.) of *Strongylus fillicollis* eggs present. These were easily recognized by their large size. After twenty-four hours fast, this lamb received thirty grains of santonin in eighty grains of saccharose.

September 13th.—Fæces now fairly firm, and while showing many ordinary-sized eggs, there is a marked diminution in the output of *Strongylus fillicollis* eggs.

These experiments show that thirty grains is a safe dose of santonin for a lamb and should be tried in those instances where smear-examination reveals a high proportion of *S. fillicollis* eggs. (*Strongylus fillicollis* is an inhabitant of of the intestine and not of the stomach.)

The Effect of Giving Salt and Iron Sulphate in the Food.

Professor Cave has advised the use of these drugs for the preventive treatment of verminous diseases, and so we thought we would see what, if any, effect large doses of these drugs would have if given for a long period.

Early in August we picked out from the College flock two small, backward lambs, four to five months old. An examination of their fæces revealed numerous strongyle eggs. We brought the lambs into a loose box where they were supplied with non-infected food and water, the former including a daily ration of ¾-lb. of good dry lamb-food. The amount of salt fed throughout the experiment was constant (thirty grains each, daily), but the iron sulphate was gradually increased in amount.

We commenced on *August 13th* to give each of them ten grains of ferri sulph. exsicc. in their dry food. They took this amount readily.

On *September 13th* we increased the daily dose to twenty grains each.

On *October 1st* we increased the amount to thirty grains each. They took this less readily, often failing to clear it all up until two or three hours had passed.

On *October 25th* we again increased the amount to forty grains each. They still take their food, but less heartily, and we do not think they would take a much larger quantity at all.

With regard to observations made during this period. The lambs have steadily gained in weight and condition. They have never scoured. The egg-output has dropped steadily, but on this date (November 1st) we can still find a a few eggs on every slide examined, so that this method of treatment has probably little injurious effect on the adult parasites in the stomach and intestine, but it may *possibly* help to arrest development of larvæ ingested. At any rate, the effect on the lambs themselves seems to have been good rather than bad.

General Conclusions.

(1) Lambs may suffer from tapeworm disease or from parasitic gastritis, but more commonly from the latter.

(2) Diagnosis is based on a naked-eye examination of fæces for the presence of tapeworm "segments"; a microscopical examination of fæces for the presence of nematode eggs; and, thirdly, the post-mortem examinations of all that die for the presence of worms. Of course one must remember that gastritis or enteritis may be due to causes other than worms (Johne's disease, indigestible fibre, etc.).

(3) Adult sheep never suffer from tapeworm disease.

(4) Tapeworm disease is comparatively easy to cure; a preparation containing extract of male-fern being most useful.

(5) For the treatment of gastro-enteritis due to nematodes no single drug is specific, except, perhaps, santonin, for the expulsion of *Strongylus fillicollis*.

(6) Drug treatment should, nevertheless, be persisted in, because, owing to tonic or other little-understood effects, improvement in the condition of the animal may occur, although only a few worms are killed.

(7) Sheep in thriving condition rarely contract the disease severely, so cake and corn for sheep are often sound investments.

(8) Sheep and lambs clinically affected should be given doses of the following mixture :—

Extract of Male Fern	7 ozs.
Oil of Turpentine	7 ozs.
Tincture Asafætida	7 ozs.
Creosote	5 drams.
Raw Linseed Oil	1 quart.

Mix well together. Give one tablespoonful for a lamb, two tablespoonfuls for a sheep, and repeat in three days.

The drugs in this combination have been found fairly effective in the treatment of parasitic gastritis during the experiments here recorded. It would appear that no single drug has acted successfully, but the combination has been shown by experiment to be worth an extended trial.

THE ARROWS SHOW THE DISEASED PATCHES IN THE LIVER.

BACILLARY NECROSIS OF THE LIVER: A DISEASE OF THE UNBORN LAMB.

At the beginning of March of this year a report was received at the College from a sheep owner in East Kent, that his ewes were dropping a large proportion of still-born lambs. As it was supposed to be a matter of agricultural interest, Mr. Garrad visited the farm and found that forty-eight Kent ewes had produced sixty-four dead lambs. The lambs were born at full term and those which survived birth were found to be strong and healthy and evidently doing well. No injury likely to cause such a loss was discovered, nor was there anything in the management of the ewe flock which could be held responsible for so many still-born lambs.

The owner then explained to Mr. Garrad that he had examined a number of dead lambs and in many he had found what he described as "spotted livers." As this seemed a possible clue to the cause of the trouble the owner was requested to send a dead lamb to the College for a pathological investigation. The first lamb arrived on March 6th. It was fully developed, the lungs contained air, proving the lamb had breathed, but the remnant of the umbilical cord was in a perfectly fresh condition, so that evidently the lamb had not long survived its birth.

An examination of the liver at once revealed its "spotted" condition. No other lesions were found in any part of the body. The illustration shows clearly the "spotted" appearance of the liver.

These "spots" had a strong resemblance to the lesions produced by the bacillus of necrosis as found in the livers of other animals, but the centre of some of the diseased patches was slightly depressed, a condition not usually seen in bacillary necrosis. Inquiries of other pathologists and a careful search through the literature of bacillary necrosis failed to discover any information as to this disease affecting the livers of unborn lambs. Bacillary necrosis is met with in

many different forms in the domesticated animals, all of which appear to be susceptible to infection. The bacilli are found in the diseased areas in long wavy filaments which are intricately interwoven. They are strict anaerobes and have a wide distribution in the soil, especially of cultivated land.

Natural infection may occur through the alimentary canal, or by means of wounds or abrasions.

The bacillus has been found in certain cases of poll-evil, quittor, ulceration of the intestine in horses.

In cattle it has been found in "foul-in-the-foot," and certain affections of the mouth. It has also been seen in necrotic areas in the livers of cattle and sheep, and in certain forms of navel-ill in both calves and lambs, but in no case, as far as can be ascertained by the writer, has it been known to cause bacillary necrosis of the livers of unborn lambs.

In navel-ill of lambs, occurring some weeks after birth, the bacillus has evidently reached the liver by way of the open umbilical vein. As a result of the invasion, numerous areas of necrosis are found in the liver.

In the outbreak under investigation the diseased condition of the liver had evidently preceded birth, as the lamb had lived, at most, only a few hours.

It appeared to us that this loss of still-born lambs might be something new to science, and a further investigation was desirable.

The owner was asked to send dead lambs as opportunity served. Altogether ten dead lambs were received and examined. In each case the umbilical cord was examined and the lungs were tested for the presence of air.

Of the ten examined, eight were found to have "spotted" livers, the remaining two showed no signs of the disease. Two other lambs were sent from another farm, but neither was affected.

The eight lambs which were found to be diseased were of different ages. Some had never breathed, as shown by the uninflated lungs; some had just breathed, but the umbilical cords were found to be quite fresh; others had lived one or two days. The oldest examined were fourteen days old. In all the same diseased areas were found in the liver. In one case, in which the lamb had lived a fortnight, a few

large diseased patches were found exactly similar to those shown in the illustration, but in addition there was a large number of much smaller areas, which it was thought *might* possibly have developed from infection through the navel *after* birth.

A microscopical examination of the diseased areas was made and the presence of the bacillus of necrosis was determined.

A shake culture of the necrosed tissue in nutrient agar was prepared and grew colonies of the bacillus of necrosis resembling small balls of cotton-wool. In glucose agar the growth caused considerable breaking up of the medium by gas formation. A rabbit was inoculated with an emulsion of the necrosed tissue into the thigh. In ten days extensive necrosis of the skin was seen. The rabbit was then destroyed and examined. There was extensive necrosis of the skin, and a circular parch of necrosis extended through the muscles of the abdominal wall at the groin down to the peritoneum. The area of necrosis in the abdominal wall had the appearance of tissues destroyed by a strong acid.

As a result of the investigations, it was concluded that the loss of about 100 lambs, mostly still-born, was due to bacillary necrosis of the liver, but no evidence could be obtained as to the origin of the disease. It was evident that the disease must have existed for some considerable time before birth, and the only route by which the bacillus could reach the liver of the fœtus *in utero* would be by the umbilical vein and the blood returning from the placenta, where the blood of the fœtus must have become infected from the uterine blood. An attempt was made to discover the presence of bacillary necrosis in the ewes, but unfortunately only one was available, and yielded a negative result, and the investigation ceased for lack of futher material.

The disease, although unknown, must have occurred on many occasions and has passed unnoticed. As it evidently is of some economic importance it is desirable that further investigations should be made, and flock-owners are earnestly requested to communicate with the Veterinary Department of the College, should any "spotted" livers be found in still-born lambs or in lambs a few days old.

T.W.C.

WEATHER REPORT, 1913.

ABSTRACT OF METEOROLOGICAL OBSERVATIONS AT THE SOUTH EASTERN AGRICULTURAL COLLEGE, WYE, KENT, DURING THE YEAR 1913.

Compiled from observations by H. C. CHAPELOW.

	Temperature.									Rainfall.				Sunshine.						
Month.	Mean Daily. Max.	Mean Daily. Min.	Mean Daily. Mean	Highest in Scrn.	Lowest in Scrn.	Lowest on Grass	Number of Frosts. In Scrn.	Number of Frosts. On Grass	Soil Temp. at 3ft. at 9 a.m.	(Inches). Total.	(Inches). Greatest Fall.	Date.	No. of Rain Days.	Total. Hrs.	Total. Mins.	Maximum in one day. Hrs.	Maximum in one day. Mins.	Date.	Bar. Mean.
Jan.	44.8	36.3	40.5	51	25	11	5	21	40.6	4.25	0.7	13th	19	42	40	5	10	12th	29.97
Feb.	45.1	36.1	40.5	52	31	17	6	20	38.3	.89	0.34	1st	10	81	40	8	50	23rd	30.22
March	47.8	39.3	43.5	55	32	27	1	14	42.9	2.59	0.58	16th	25	95	45	8	30	20th	30.00
April	52.7	41.4	47.0	65	33	28	2	6	42.8	3.10	0.9	3rd	19	114	50	10	10	23rd	29.92
May	61.8	47.0	54.4	79	38	31	nil	3	49.4	0.90	0.26	3rd	8	159		9	30	27th	29.90
June	65.9	50.3	58.1	82	43	34	nil	nil	55.5	1.12	0.62	20th	8	161	10	12	20	15th	29.94
July	66.2	53.7	59.9	70	47	41	nil	nil	57.2	2.69	0.55	15th	17	97	20	9	40	12th	29.98
August	71.1	54.8	62.9	83	44	35	nil	nil	57.5	1.78	0.58	7th	14	137	0	8	50	21st	29.99
Sept.	68.1	55.5	61.8	75	45	35	nil	nil	56.7	1.22	0.48	16th	9	149	35	10	20	24th	29.96
Oct.	62.6	50.5	56.5	74	38	28	nil	4	53.4	4.45	0.5	26th	16	124	0	9	40	11th	29.86
Nov.	56.3	45.9	51.1	65	35	27	nil	10	48.0	6.51	0.89	21st	16	61	60	7	20	15th	29.95
Dec.	47.7	41.4	44.5	65	31	22	2	10	43.2	3.68	0.8	3rd	11	43	50	4	40	19th	30.12
The Year	57.5	49.0	51.7	83	25	11	16	88	47.9	33.18	0.9	—	172	1268.50		12.20		—	29.98

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